

*A webcomic of romance, sarcasm,
math, and language*

xkcd

RANDALL MUNROE

2018

xkcd

2018

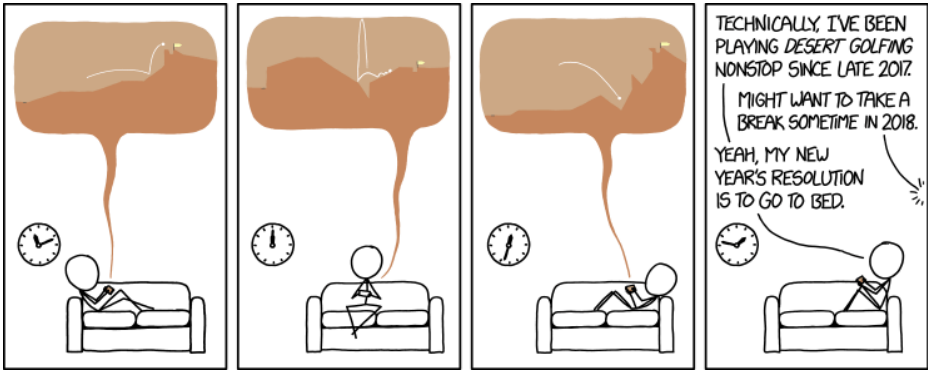
a collection of 157 webcomics

from #1936 to #2092

by Randall Munroe

#1936: Desert Golfing

January 01, 2018



I just want to stay up long enough to watch the ball drop into the hole number **2018**.

Explanation

A common joke surrounding the turn of the New Year is to make a comment about "next year" on New Year's Eve or "last year" on New Year's Day. While technically correct, some people may derive a snarky humor from making observations about the span of years when the reality has been more along a span of days or even, as in this comic, only a few hours.

In this, the second of two New Year comics in a row, with this one being released on New Year's Day 2018, Cueball observes that he has technically "been playing Desert Golfing nonstop since late 2017". Desert Golfing is a game that takes place in an side-scrolling desert, where the player can shoot a golf ball using a one finger swipe to determine direction and power. The entirety of the "golf course" is made of sand, making the physics of the golf ball more difficult to predict and control, as if from a bunker. After reaching a hole, the game automatically generates a completely new hole, with a ludicrous total of 10,000 holes needed to complete the entire game.

Although Cueball's statement could be taken to mean he has devoted his waking hours to the game, the clock on the wall reveals both the truth of his comment and that he is not exaggerating. While he has only been playing the game for two and a half hours, give or take, those two-and-a-half hours started at about 11:10 PM on December 31st, meaning that it is presently January 1st

and he has indeed been playing the game "nonstop since late 2017" (assuming he has not taken a break to eat or use the facilities).

Someone off-panel acknowledges the joke by saying that he should "take a break in 2018", and Cueball declares it is his New Year's resolution to go to bed. This is not a typical New Year's resolution, as most resolutions are about something you need to change in your life from last year, and going to bed (or at least sleeping) is not something you would have been able to avoid for a whole year.[citation needed] This may also be making a joke about how quickly many New Year's resolutions are broken, as Cueball has singularly failed to stick to his. New Year's resolutions have been mentioned before, the first time in 1154: Resolution, where the tradition of New Year's resolutions is the entire joke.

The title text states that the only reason Cueball has stayed up to play Desert Golfing is to watch the ball drop into hole number 2018 — this is a pun on the Times Square Ball, a pyrotechnical device in New York City that lights up spectacularly as soon as the new year begins. Because the event is televised on many news channels, "watching The Ball drop" is now a common way to count down the seconds to the new year. Cueball takes this literally, and tries to drop his (golf) ball to signify the beginning of 2018.

#1937: IATA Airport Abbreviations

January 03, 2018

CONFUSED BY THOSE AIRPORT
ABBREVIATIONS USED BY YOUR
FRIENDS WHO FLY A LOT?

JUST MEMORIZE THIS LIST!

I'M FLYING INTO EWR TONIGHT,
THEN DTW TOMORROW.

OK, COOL

I DEFINITELY KNOW
WHAT THOSE MEAN
WITHOUT GODGLING

AMD	AMSTERDAM	TMI	TURKMENISTAN INTERNATIONAL
BAE	BEIJING	LAX	LAS ANGELES
ORD	ORLANDO	EWB	EDWARDS AIR FORCE BASE
IDA	IDAHO (BOISE)	PHL	PITTSBURGH
JFC	JEFFERSON CITY	SWF	SHERWOOD FOREST
IAD	WASHINGTON DULLES	KUL	KINGDOM OF LOATHING
FYI	FAYETTEVILLE	STL	SILENT HILL
LOL	LOUISVILLE	BUF	SUNNYDALE
ATL	ATLANTA	TBA	TRIBECA
HGM	HOGSMEADE	SMH	SMITHFIELD
OMW	OMAHA	BLT	BALTIMORE
ANC	ANCHORAGE	YYZ	TORONTO DOWNTOWN
HSV	HUNTSVILLE	YYZ	TORONTO PEARSON
SAN	SAN DIEGO	MIA	COLOMBO, SRI LANKA
SAN	SAN JUAN	CLT	[CENSORED]
SAN	SAN JOSE	FHQ	FHQWHGADS
SAN	SAN FRANCISCO	FFS	FLAGSTAFF STATION
SAN	SAN ANTONIO	DTF	DARTFORD
DWI	DELAWARE INTERNATIONAL	MDW	MIDWAY ATOLL
DFW	DOWN FOR WHATEVER	PDX	PORTLAND
DTW	DOWN TO WHATEVER	SEA	[INDICATES WATER LANDING]

IATA stands for International Airport Abbreviation.

Explanation

This comic is making fun of the three-letter codes assigned to major airports in the world. These codes are overseen by the IATA (International Air Transport Association). Some airport codes are very intuitive, taking letters from the city name (e.g., DEN for Denver). Other codes are somewhat intuitive, taking a letter or two from the nearby city name but adding an additional letter (e.g., LAX for Los Angeles). Other codes make seemingly no sense at all (e.g., ORD for Chicago's O'Hare International, due to it formerly being named Orchard Field). In many cases, the airport codes appear to have been chosen (or invented) because they are also common abbreviations and acronyms. Randall is obviously confused by these codes, replying to his friend that he definitely knows what those mean without googling, basically revealing that he used Google to search for the codes, and has created a list for us to memorize. In fact, this list is complete nonsense, with some of the "airports" mentioned not even existing, and the existing airports are all paired with the wrong codes, except for Huntsville (HSV), San Diego (one of the instances of SAN) and Toronto Pearson (YYZ).

If we use the table provided, Randall's friend is flying into Edwards Air Force Base and then "down to whatever" -- not a real flight.[citation needed] In actuality, the friend is flying into Newark tonight and Detroit tomorrow.

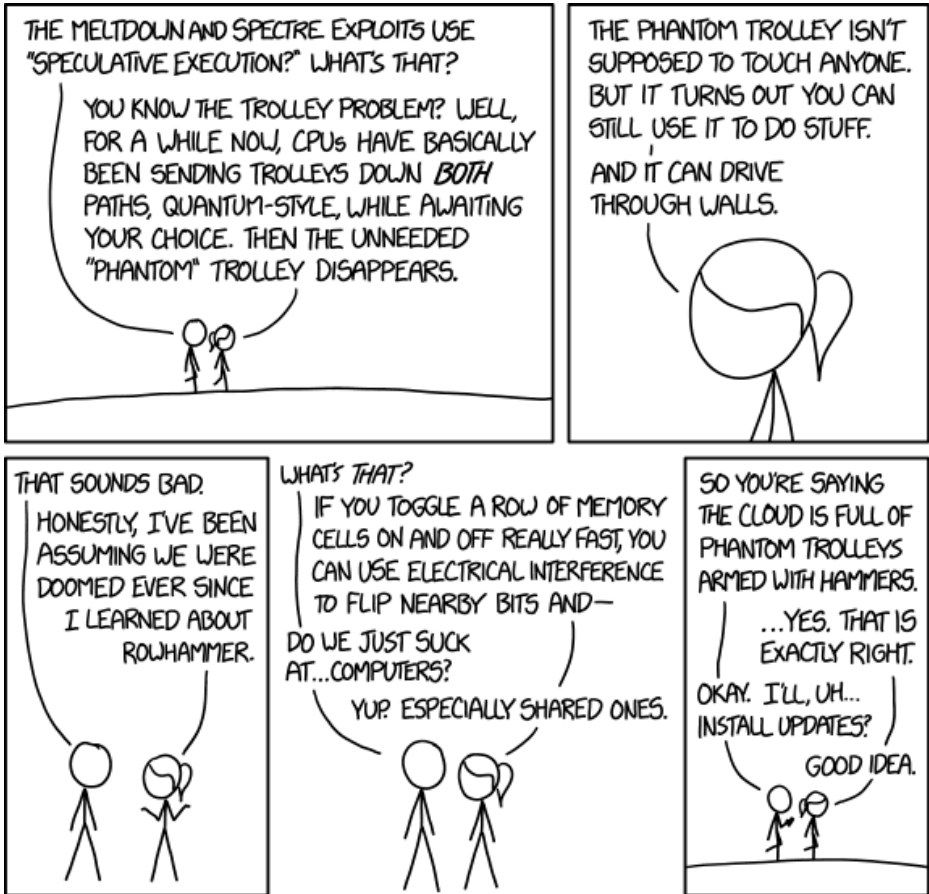
The title text is a pun about the acronym IATA, stating it stands for International AirporT Abbreviation. This is as wrong as almost everything else here, because the real International Air Transport Association is not an organization only responsible for abbreviations in aviation. This acronym also leads to some redundancy in the title by making the true title of the comic be "International Airport Abbreviation Airport Abbreviations," which might be an example of RAS syndrome.

This comic could be inspired by the recent news about an Indian businessman charged with making a bomb threat at a Mumbai airport claiming he was misheard by a telephone operator while asking for the BOM to DEL flight status.

It may also be a reference to tongue-in-cheek 'teen texting code' explanations for older generations.

#1938: Meltdown and Spectre

January 05, 2018



New zero-day vulnerability: In addition to rowhammer, it turns out lots of servers are vulnerable to regular hammers, too.

Explanation

This comic was inspired by the Meltdown and Spectre bugs found in certain processors; these vulnerabilities were disclosed to the public in the week of this comic. The bugs result from flawed implementations of speculative execution, and made big news because they broke the "walls" between programs executing concurrently on the same computer, in some circumstances allowing malware to steal secrets from normal, bug-free programs.

Speculative execution is a technique used to speed up the execution of computer programs. Processors handle instructions in a series of steps, like an assembly line. The processor works on several successive instructions, each at a different stage in the assembly line. It may start speculatively executing instructions that follow a particular result of a decision before the execution of the logic that makes that decision is finished. Once the decision is made, it keeps results from the selected path, and discards unnecessary results. This allows it to keep doing useful work while some slower decision is made.

In the Meltdown and Spectre bugs, the results of speculatively executed instructions are not completely discarded, allowing them to affect things that the program logic should have prevented.

Ponytail uses the Trolley Problem, and trolley (tram) tracks in general, as an analogy for streams of instructions

in a program. The Trolley Problem is a thought experiment where an out-of-control trolley is heading to a switch which you control. Leaving the switch as-is will cause it to kill multiple people (typically five) stuck on the tracks, but switching the track will cause it to kill only one person, who would not have died if the switch was left untouched. This creates the ethical dilemma of passively causing multiple deaths, versus actively causing one. The Trolley Problem has gained significant memetic traction, helped in no small part by its frequent inclusion in “introduction to philosophy” type courses. The problem has seen revitalized interest with the emergence of autonomous cars, which may be faced with what are, essentially, such choices in emergency situations.

As an analogy for multiple mutually exclusive paths being executed at the same time, Ponytail invokes certain interpretations of quantum mechanics, where quantum-level particles can be viewed as taking every possible path at once, with the result being the sum of all of them. This is an idea popularized by the common interpretation of Schrödinger’s cat, where the cat is both dead and alive until some event results in one of the states being selected.

The phantom trolley driving through walls is an analogy for the computer instructions being able to access areas of memory that should be protected from them. This may also be a reference to quantum tunnelling, or even simply a joke about the phantom trolley being a literal phantom, i.e. incorporeal.

In many cases, contrary to what the comic implies, both paths are not taken simultaneously during speculative execution. A branch predictor may be used to select the most likely path, and the effects should be completely erased if the predicted path is incorrect. To use Ponytail's analogy, a phantom trolley is sent down one path (hopefully the most likely one), and either becomes real once it's determined that that path was correct, or vanishes and is replaced by a real trolley starting down the other path from the branching point. Both branch prediction and taking both paths (known as eager evaluation) are considered speculative execution and are affected by these bugs.

The Row hammer problem had been known for many years before this comic was published. A common form of computer memory is constructed from tiny capacitors organized in a two-dimensional grid of rows and columns. Capacitors store charge to represent information. By applying a pattern of memory access that rapidly changes a row of capacitors, you can cause charge to overflow to nearby rows and incorrectly change their states.

Ponytail mentions that we especially suck at building "shared computers" because Row hammer, Spectre, and Meltdown all break down the security divisions built between programs and between users. A hacker running a separate program in a separate account shouldn't be able to access your data or change the behavior of your program, but these problems allow them to. This is particularly dangerous for time-sharing, servers, and the

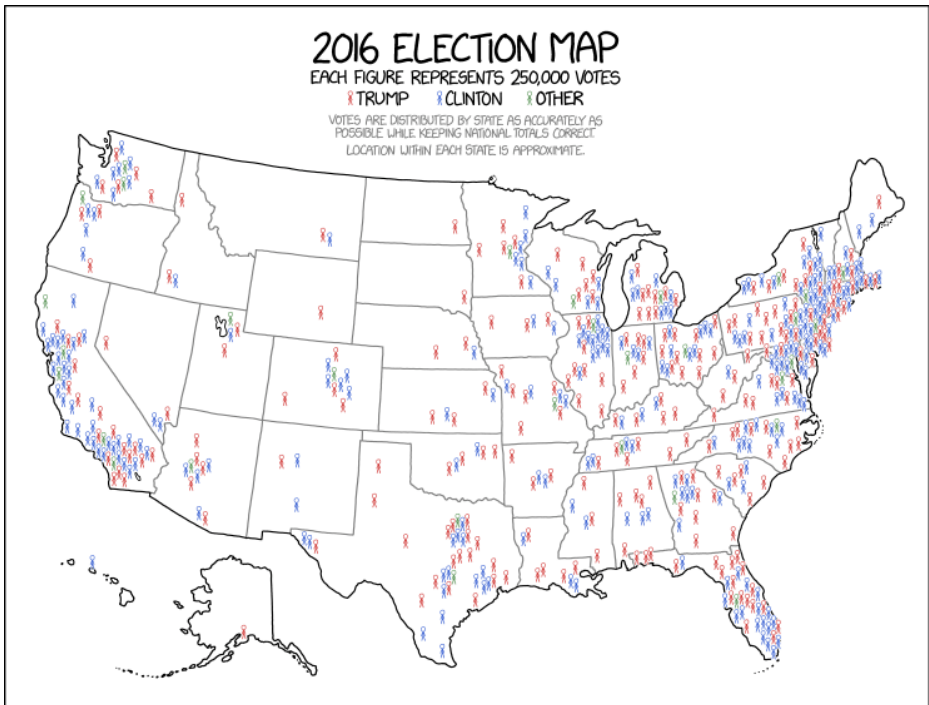
cloud, where different programs, websites, or even companies can be sharing the same hardware.

Cueball takes her explanation literally, and comes to the conclusion that the cloud "is full of phantom trolleys armed with hammers", and Ponytail cannot be bothered correcting him (it could also be, considering xkcd's absurdist humor, that this quite literally is the case in the comic's world, and Ponytail is telling Cueball that he is indeed correct). Cueball's final line ironically suggests that these exploits can be repaired with a simple software update. This seems to be mocking the naive misunderstanding that software can make up for flawed hardware. However, the exploits discussed in this comic are not trivial oversights, but reflect fundamental issues in the design of modern processors.

A zero-day vulnerability is an attack that takes advantage of a vulnerability that hasn't been published yet, and so is not patched in any vulnerable system. The title text suggests that, until it was 'disclosed' here, nobody was aware that as well as Row hammer, computer servers can also be harmed by regular hammers. In reality, this would be obvious to most people.[citation needed] One might "patch" a server against this attack by plating it with stronger metal.

#1939: 2016 Election Map

January 08, 2018



I like the idea of cartograms (distorted population maps), but I feel like in practice they often end up being the worst of both worlds—not great for showing geography OR counting people. And on top of that, they have all the problems of a chloro... chorophl... choropet... map with areas colored in.

Explanation

The United States elects its president not directly by popular vote but by an Electoral College composed of a number of electors, partially proportional to population, from each state. Presently, a "winner-take-all" system is used in most states: the winner of the popular vote in each state receives all of the electoral votes for that state. Though, strictly speaking, the electors are not required to cast their ballots according to this system, many states impose penalties on them if they don't. Technically, the popular vote in each state is to elect a slate of electors who in turn elect the President. Many Republicans tend to claim that Trump had a strong victory, and show maps filled with large, red counties. These maps look even redder than the state maps, so they make it look like Trump won a large nationwide victory. However, as Randall points out, those maps are misleading, and using them to promote your candidate is a bit disingenuous.

The news media commonly use maps to represent the progress or results of the election. Because of this winner-take-all system, states won by the Democratic candidate are typically portrayed in one color (blue is currently in wide use), and states won by the Republican candidate in another (currently red). In recent years, this distinction has gone far beyond electoral maps, and states are often referred to as "blue" or "red" by their political leaning in many contexts.

Randall seems to be making a point on the shortcomings of both maps, by showing how different the actual vote was from the red and blue choropleth maps. He mentions how strange cartograms look, and by creating this map he hopes that it will convey the actual vote by geography well, while keeping the normal geographic boundaries.

The title text repeatedly attempts and fails to spell the term choropleth map, a map that uses shading or colors to show information about a geographic area. A choropleth map for elections has many shortcomings. For example, many large Western states have small populations and thus don't make much difference to the electoral vote count, but look like a broad swath of red or blue on the map. The map overall can have the appearance of being very red or very blue, suggesting to the eye an overwhelming victory, when in fact the election may be extremely close. Donald Trump has repeatedly emphasized how red the map appears, especially when broken down by county, even though he actually lost the popular vote. In a speech on June 21, 2017, he said, "And those maps, those electoral maps, they were all red. Beautiful red."

In this cartoon, Randall seems to be pointing out the shortcomings of the choropleth map (or perhaps this overall red-state/blue-state mentality). His map shows more clearly the small impact of the low-population states, as well as how combination of the winner-take-all system with the typical election maps fails to show the sometimes large number of opposition votes in a given

state. This map also combines all third-party or independent candidate into one type of marker (green, likely as the third primary additive color available, but at least in part would represent the Green Party), making it clear that a substantial number of votes went to these candidates.

A cartogram, also referenced in the title text, is a map that changes the size, and sometimes shape, of a region based on population or some other metric. Like a choropleth, these maps also have many shortcomings, the most obvious being the distortion required for the maps to work sometimes making it difficult to tell what and where the region actually is. Many versions of cartograms use squares to represent each region, with the size of the square corresponding to the metric measured. Often, it's easier to find specific places on these square maps.

A similar map was actually used during the 2016 election by the Financial Times (discussed here). It made similar use of colorless states for geographic information and color in proportion to population for electoral information. However, the FT map is based on the electoral college, not the popular vote. It in turn is similar to a 2013 map used by The Guardian for the 2013 Australian election (discussed here). Other compromise maps of geographic and electoral information exist, such as maps of geographically accurate but re-scaled states: a 2016 election example is here, indirectly inspired by a similar vox.com map.

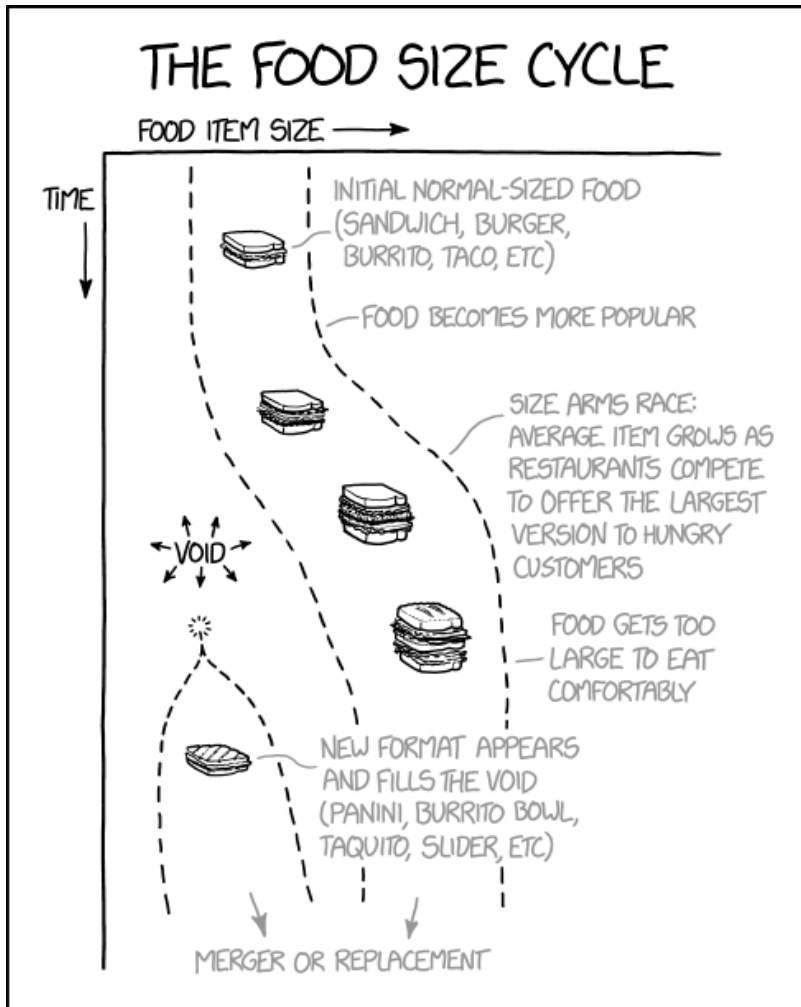
With a stick figure representing 250,000 votes, Trump

would have exactly 251.918544 stick figures and Clinton would have exactly 263.37844 stick figures according to the final results. The map shows 252 Trump stick figures and 264 Clinton stick figures, meaning Randall used ceiling rounding instead of conventional rounding, which would have shown Clinton with one fewer stick figure.

Table[\[edit\]](#)

#1940: The Food Size Cycle

January 10, 2018



There's data suggesting that this model may apply to deep-dish/thin-crust pizza. I've designed a thorough multi-year study to investigate this personally, but funding organizations keep denying my grant requests.

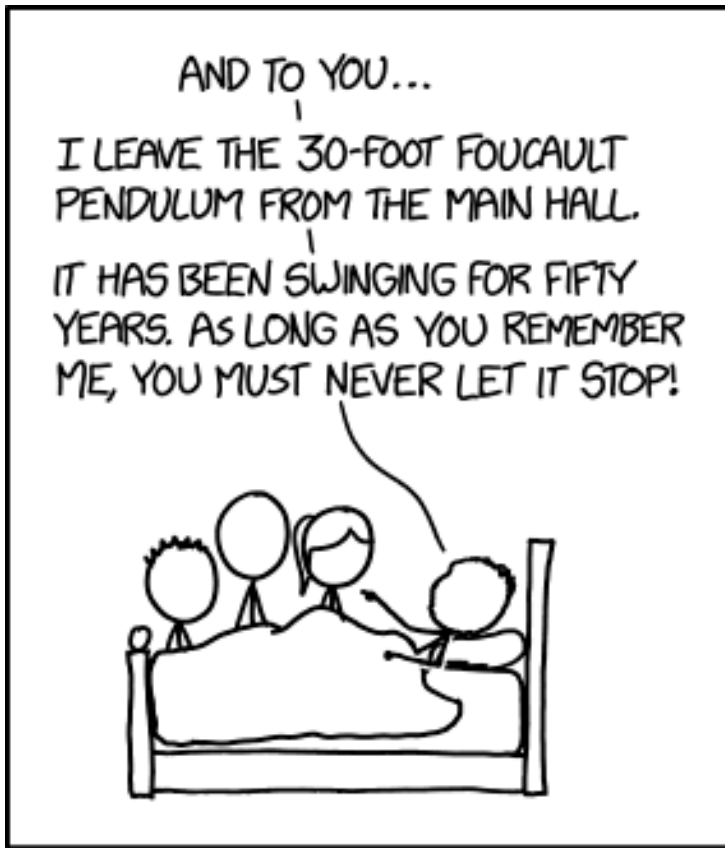
Explanation

This comic illustrates the evolution of the size of food items over time, using the example of a sandwich. It starts with a regular sandwich at the beginning. As the sandwich became more popular, sandwich makers had an arms race concerning sandwich size as they competed for customers. Eventually, these sandwiches became too big to eat comfortably. At this point (according to Randall) some smart guy invented the panini, a small sandwich, to cater to those who couldn't find a sandwich small enough for their needs. Eventually, the panini itself will begin to grow, and either displace or become indistinguishable from the existing giant sandwiches, and the cycle will repeat. This is similar to Clayton Christensen's theory of disruption, where products keep adding features beyond what is needed by customers, and is then resolved by cheaper products with adequate features.

The title text suggests that the same cycle may be applicable to the depth of pizza crust, with thin crusts being replaced with deeper and deeper ones, eventually necessitating a resurgence in thin crust. Randall laments that despite seeking funding to conduct experiments to test that hypothesis, he keeps getting turned down, probably because it sounds suspiciously like he wants to be paid for eating pizza.

#1941: Dying Gift

January 12, 2018



A FUN PRANK: AS YOU'RE DYING, LEAVE PEOPLE GIFTS THAT WILL BE AS DIFFICULT AS POSSIBLE TO PUT INTO STORAGE.

And to you, I leave my life-sized ice sculpture replica of the Piet which was blessed by the Pope. You must never let it melt! Now, remember, all gifts must be removed from my estate within 24 hours.

Explanation

In some cultures it is customary to make bequests, usually in written form called a will, of some or all of your possessions, to be given to people close to you after your death. Often, items bequeathed may be of purely sentimental value to the giver. That sentimental value may not carry over to the recipient, but they may, nonetheless, feel obliged to keep possession of them in order to respect the giver's wishes. In some cases, if the items are unwanted, unusable, or the recipient simply doesn't know what to do with them, they may elect to place the items in storage, rather than dispose of them.

Randall therefore suggests the following prank to be played by someone near death: bequeath an item that is intentionally very difficult to store or even move. In this case, the old dying man gives his Foucault pendulum to someone in his family.

A Foucault pendulum is a type of pendulum that is commonly used in science museums to practically demonstrate the rotation of the Earth. In order to attain the sensitivity required to do this, the pendulum must be very long - in this case, it is thirty feet (approximately nine meters) in length: about the height of a large hall. It must also be undisturbed; any disruption, such as a touch on the pendulum, will prevent it from accurately portraying the rotation of the Earth.

By insisting that the pendulum never stop swinging, the

old man has made it impossible for the pendulum to be simply detached and stowed away. Even transporting it will be extremely difficult, as it is thirty feet tall, and any change to its orientation will disrupt its swing. (Note, however, that the old man didn't specify that it has to work as a Foucault pendulum; merely, that it must not stop swinging.) He has also added an extra layer of guilt to the 'gift' by suggesting that if they do ever let it stop swinging it will be because they have forgotten him.

The title text takes it even further, with a life-sized ice sculpture replica of the Pietà which was blessed by the Pope. A Pietà is a representation of the body of Jesus Christ on the lap of his mother, Mary, in the aftermath of his Crucifixion. When styled "The Pietà" it usually refers to Pietà a Renaissance sculpture by Florentine artist Michelangelo. It is widely considered one of the masterpieces of sculpture. While replicas of Pietà do exist, there are none known to have been made of ice, let alone made of ice and blessed by the Pope. That said, if such a sculpture were made, there are several ways to obtain a papal blessing. Such a sculpture would be over six feet tall and weigh several tons, and would have to be constantly maintained at sub-zero temperatures. While the gift could potentially be very valuable, the statement "all gifts must be removed from my estate within 24 hours" would dramatically increase its chances of melting.

For both the pendulum and the ice sculpture, it is theoretically possible to devise a way to remove, transport, and store them with all the necessary

conditions met, but they would probably be huge and very expensive logistical feats, requiring substantial planning and preparation. The final condition that everything must be removed within 24 hours makes such a feat practically impossible.

As a side note: Catholic canon law would discourage selling such a sculpture and, were such a sculpture to melt, the water would need to be collected "burned, buried, or consumed". These are the proper ways to dispose of a blessed object.

Alternatively, the title text could be read as meaning that there is a Pietà that has been blessed by the Pope, which formed the basis for this replica, though that would make the ice sculpture itself somewhat less remarkable.

#1942: Memorable Quotes

January 15, 2018

LOOKING FOR A QUOTE FOR SOMETHING?

HERE ARE SOME FOR GENERAL USE.

THEY CAN BE ATTRIBUTED TO XKCD
OR RANDALL MUNROE AS NEEDED

"I DISAGREE STRONGLY WITH WHATEVER
WORK THIS QUOTE IS ATTACHED TO."

"THIS QUOTE WAS TAKEN OUT OF CONTEXT."

"THIS QUOTE IS OFTEN FALSELY
ATTRIBUTED TO MARK TWAIN."

"I'M BEING QUOTED TO INTRODUCE SOMETHING,
BUT I HAVE NO IDEA WHAT IT IS AND CERTAINLY
DON'T ENDORSE IT."

"THIS QUOTE IS VERY MEMORABLE."

"I WROTE THIS BOOK, AND THE PERSON
QUOTING ME HERE IS TAKING CREDIT FOR IT."

"THIS ENTIRE THING IS THE QUOTE, NOT JUST THE
PART IN QUOTE MARKS." [QUOTE MARKS, BRACKETS,
AND EDITOR'S NOTE ARE ALL IN THE ORIGINAL.—ED.]

"WEBSITES THAT COLLECT QUOTES ARE FULL OF
MISTAKES AND NEVER CHECK ORIGINAL SOURCES."

"THIS QUOTE WILL BE THE ONLY PART
OF THIS PRESENTATION YOU REMEMBER."

"DOOH, LOOK AT ME, I LOOKED UP A QUOTE!"

"IF YOU'RE DOING A TEXT SEARCH IN THIS DOCUMENT
FOR THE WORD 'BUTTS' THE GOOD NEWS IS THAT
IT'S HERE, BUT THE BAD NEWS IS THAT IT ONLY
APPEARS IN THIS UNRELATED QUOTE."

"WAIT, WHAT IF THESE QUOTE MARKS ARE INSIDE OUT,
SO EVERYTHING IN THE REST OF THE DOCUMENT IS
THE QUOTATION AND THIS PART ISN'T? DUUUUUUDE."

"THE EDITORS OF BARTLETT'S FAMILIAR
QUOTATIONS ARE A BUNCH OF COWARDS
WHO DON'T HAVE THE GUTS TO PRINT THIS."

"THIS QUOTE ONLY LOOKS PROFOUND WHEN IT'S
IN A SCRIPT FONT OVER A SUNSET."

"I DON'T DO A LOT OF PUBLIC SPEAKING, SO I
LOOKED UP A MEMORABLE QUOTE TO START MY
SPEECH, AND THIS IS WHAT I FOUND. OK, YOU'RE
STARING AT ME BLANKLY BUT THIS WHOLE THING
IS A QUOTE. I KNOW THAT SOUNDS CONFUSING
BUT ... YOU KNOW WHAT, NEVER MIND"

"SENT FROM MY iPHONE"

"Since there's no ending quote mark, everything after this
is part of my quote. -Randall Munroe

Explanation

This comic "helpfully" provides random quotes to be used by anyone as blurbs, online reviews, motivational quotes or similar short bits of text. Either the webcomic xkcd or its creator Randall Munroe may be quoted when using any of the provided lines, as stated at the top of the comic.

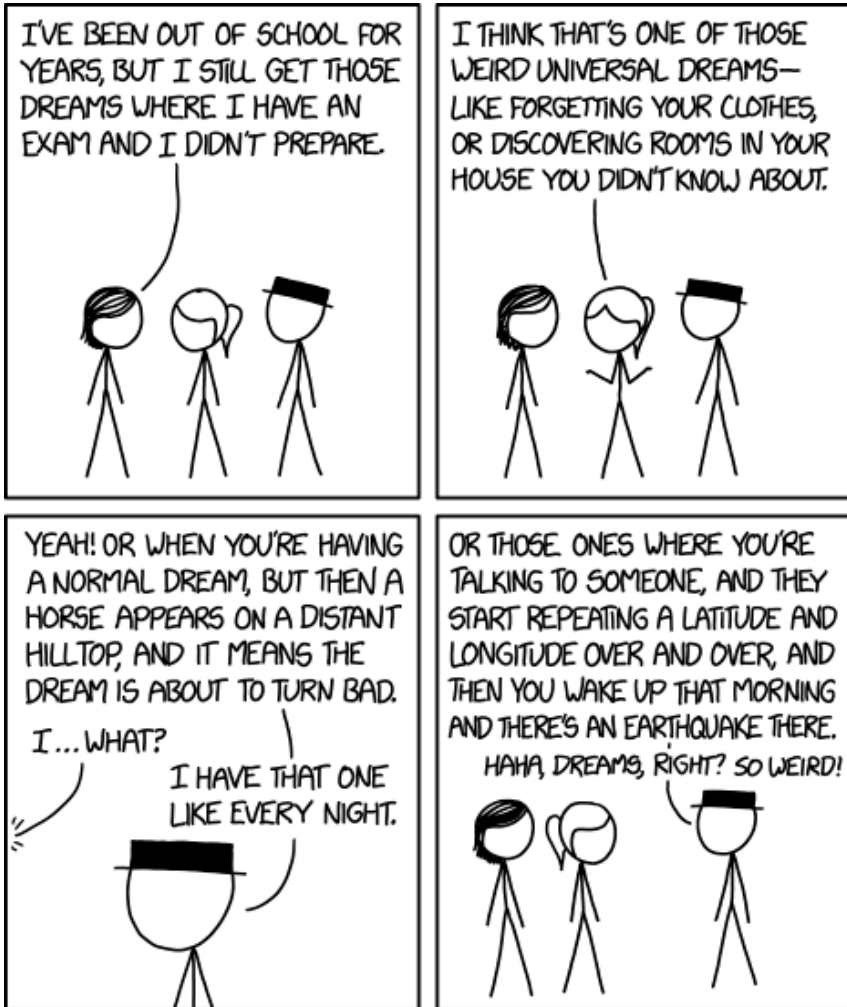
In particular, their "usefulness" lies in the fact that almost any of them are equally applicable to almost any situation. This is achieved by making each quote not really about anything in particular, aside from the fact that they are quotes. This is in contrast to typical quotes, which are never quite this aware that they will be quoted, but this is to be expected when the lines here were made solely for being quoted.

These self-aware quotes are, on a meta level, jokes about quotations generally. Most of Randall's quotes either sabotage the quoting work, reference some aspect of quotes as used in practice, or both---and it can be both when the aspects referenced are about twisting people's words to look like they agree with you.

The title-text does not have an ending quote mark, so "- Randall Munroe" is part of the quote, and possibly everything in xkcd after that until the next ending quote. Note that the next quote mark in xkcd is in 1946: Hawaii.

#1943: Universal Dreams

January 17, 2018



"That's ... unsettling." "Yeah, those definitely don't sound like the normal drea- ..."

Explanation

The first and second panel are a discussion between Megan and Ponytail about dreams. Megan mentions a dream or nightmare about failing to prepare for an exam, despite not being a student for years. This is similar to the dream depicted in 557: Students. Ponytail responds that certain dreams occur with surprising frequency among many people, dubbing them "Universal Dreams" (which is the title of the comic). Universal dreams are dreams that are weirdly common, as also abused in 719: Brain Worms.

In the third panel, Black Hat describes an avatar of misfortune in the form of a horse appearing on a hill. This could be a play on the word nightmare. A mare was originally a demon or goblin that gave bad dreams. The modern word mare, meaning female horse, has a different origin, but still serves handily as a homophonic pun.

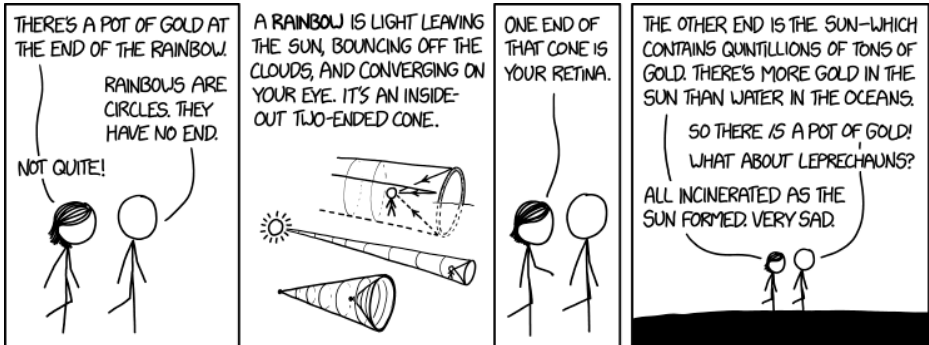
Alternatively, this may be a reference to the 2007 film Michael Clayton, which features a dreamlike sequence where the title character recognizes a scene of three horses on a hilltop from an illustration in a book. He stops his car, gets out and approaches the horses, just minutes before his car explodes. This marks a major turning point in the direction Clayton takes for the rest of the film, similar to how Black Hat says "[the horses] mean the dream is about to turn bad."

In the last panel, Black Hat describes having dreams where he receives specific information about the real world, which seems closer to prophesying or precognition than what would be considered a normal dream, as normal dreams do not tell the future.[citation needed] This may be a reference to the 2009 film *Knowing*, in which a child hears voices telling her the date, time, latitude, and longitude of major disasters (including earthquakes) that will occur 50 years in the future. This could also be a reference to comic 240.

In the title text, either Megan or Ponytail is responding to Black Hat when she unexpectedly interrupts herself with the first part of geographic coordinates (Latitude 35), just as Black Hat described, implying that the whole comic might be another of Black Hat's dreams. 35 degrees North would include 31 major cities around the world, including 11 in Japan and 8 in the USA (including California, a seismically active region); the only major city within 35 degrees South is Canberra, Australia. This would suggest that an earthquake would happen soon in one of those major cities. The remainder of the coordinates are most likely cut off to add uncertainty to the situation.

#1944: The End of the Rainbow

January 19, 2018



The retina is the exposed surface of the brain, so if you think about a pot of gold while looking at a rainbow, then there's one at **BOTH** ends.

Explanation

Megan appears to reference the myth that at the end of every rainbow lies a leprechaun's pot of gold. Instead of claiming that leprechauns and their gold don't exist, Cueball offers the refutation that, technically, rainbows are circles, so they do not have an end. This is true for an idealized rainbow, and for some actual rainbows: if the viewer has an unobstructed view of the light-reflecting substance creating the effect for the whole of the circle's circumference, they could see a full circle. In practice, the circle is often broken by the horizon or, for example, discontinuity in cloud cover.

However, Megan counters that if one considers the path that light takes to form a rainbow, then it forms a two-cone structure, where the Sun (the vertex of the outer cone) emits light rays that move towards the Earth (forming the faces of the outer cone), then reflect off water droplets located at just the right angle (the circular base) to reach our eyes (the vertex of the inner cone). Thus, such a rainbow structure can be said to have "ends", represented by the vertices of the two cones: one at the eye of the viewer, and another at the light source (usually the sun).

A common rainbow (for which the base is formed by a water droplets in the Earth's atmosphere) can not be viewed as that. The Sun's diameter is orders of magnitude greater than Earth's one (even including the outer layers of the atmosphere), and we would expect the apex of a

cone to be much smaller than its base. Thus a two-cone rainbow which ostensibly starts in Sun shall have its effective base formed in the outer space. Or, rather, be a smudged out sum of all point origins lying within the near-hemispheric visible glowing atmosphere of the Sun, refracted by whatever solar atmosphere they each immediately have to pass through in order to arrive at the droplets, and thence back towards our eyes.

Megan then says that the Sun is indeed a pot of gold. The Sun is approximately 1.989×10^{30} (1 nonillion 989 octillion) kilograms, and its abundance of gold is approximately 0.3 parts per trillion (ed: this value is incorrect - values in the paper are not in ppt - see comments below). Based on these numbers, the sun contains 5.967×10^{17} (596 quadrillion 700 trillion) kilograms of gold. This equates to 5.967×10^{14} (596 trillion 700 billion) metric tons of gold. As such, Megan's statement that the sun contains "quintillions of tons of gold" is off by a factor of roughly 4000, but the amount of gold within the sun is, nonetheless, far more than a pot's worth.[citation needed]

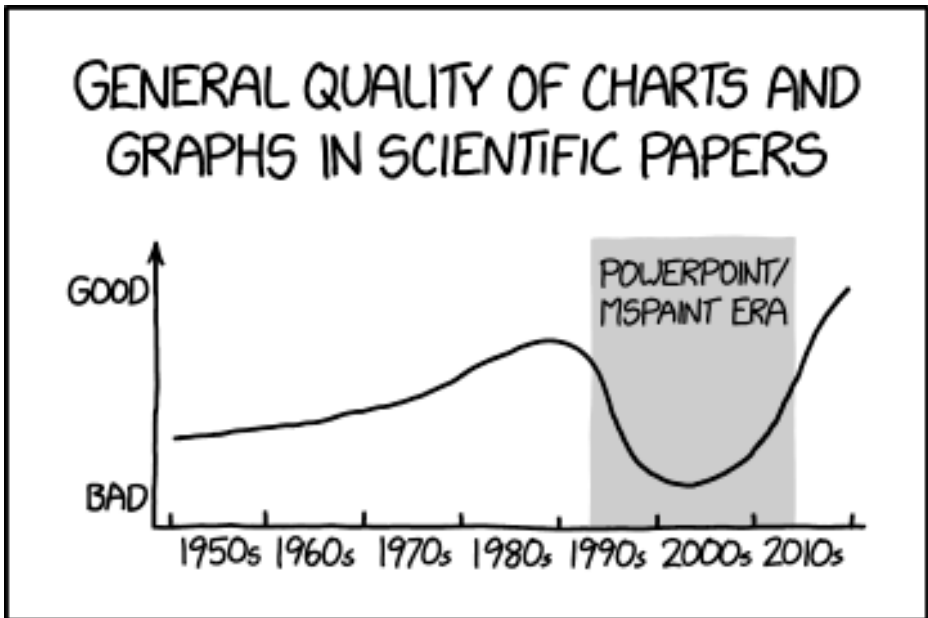
The amount of water in the oceans is about 1.35×10^{18} (1 quintillion 350 quadrillion) metric tons. If we assume that Megan is still talking in terms of mass rather than volume or molecule count, then her next statement (that there is more gold in the sun than water in the oceans) would have been true had she been correct in her previous claim, but in fact there is more sea-water than sun-gold by a factor of roughly 2300.

Cueball then asks about leprechauns (perhaps ironically, since Megan's theory at this point appears to involve astronomy/physics, not mythical creatures/beings). Megan replies that the leprechauns all died when the Sun formed, building on the irony of Cueball's question (and opening questions about the role of leprechauns in the early formation of our solar system).

The title text suggests that, since the pot of gold exists as an idea in the brains of people thinking about it, and the retina is the foremost part of the brain for light perception, it can be argued that, in addition to existing in the sun as the comic explains, the gold (and leprechauns) also exist at the perceiver's end of the cone, as long as they are thinking about a pot of gold at the time (and then it's gone as soon as they stop thinking about it). Many neurologists would agree with the concept that ideas in your mind can be said to be physically located in your brain. However, this seems to go further, and suggest an idealist ontological position, that things, in this case a pot of gold, exist by virtue of our having an idea of them.

#1945: Scientific Paper Graph Quality

January 22, 2018



The worst are graphs with qualitative, vaguely-labeled axes and very little actual data.

Explanation

Microsoft Paint was first introduced in 1985 as a component of Windows 1.0, and Microsoft PowerPoint debuted in 1990. As easy-to-use tools, these allowed for the easy creation of graphs by computer users. The comic implies that these are responsible for decreasing the overall quality of graphs in scientific papers, presumably by enabling a large number of inexperienced designers, and encouraging certain kinds of designs that are ineffective for communicating scientific results.

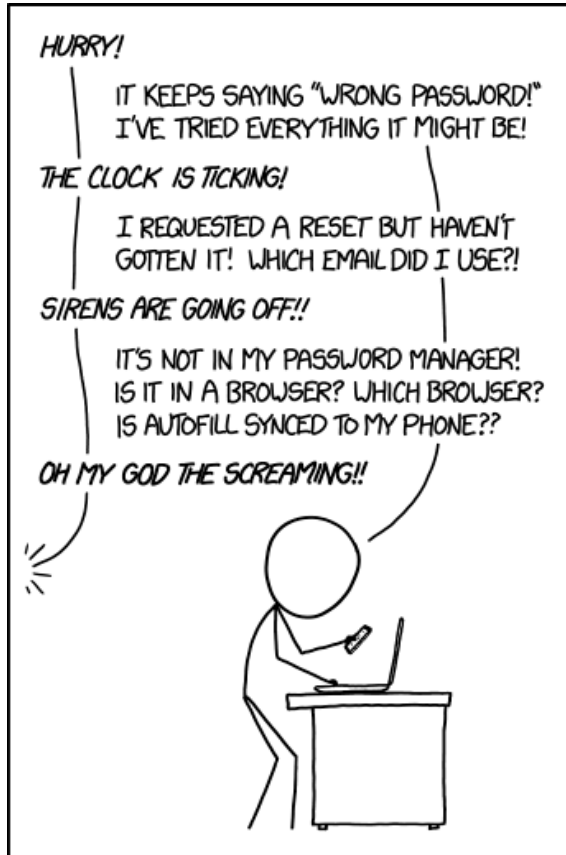
Critics of PowerPoint, such as Edward Tufte, have argued that the software is ill-suited for reporting scientific analyses. Many scientific journals nowadays explicitly forbid the use of PowerPoint in their instructions for authors. It can be argued that other software specifically built for this task - and techniques to do so - have been refined over time, leading to a rise in graph quality outside the PowerPoint/MSPaint era (though see discussion).

The title text states that among the bad quality graphs, the ones “with qualitative, vaguely-labeled axes and very little actual data” are the worst. While this may indicate that the problem with PowerPoint era graphs is that they seem to focus on getting the point across (qualitative as in “you get the idea”) over accuracy (little actual data), this is more hypocritical humor on Randall’s part, as the comic itself features exactly that sort of lambasted graph. The vertical axis labeled “good” and “bad” is entirely

qualitative, the horizontal axis manages to use numbers and still be vague by labeling the area between the ticks as decades instead of labeling the ticks, the definition of what constitutes the 'PowerPoint / MSPaint era' is entirely unclear, and it is doubtful that any actual data was used to make the graph – certainly there are no actual data points indicated. Its quality is doubtful, and it might represent more of an impression, or opinion, than an actual fact.

#1946: Hawaii

January 24, 2018



I FEEL BAD FOR EVERYONE IN HAWAII, BUT
WHEN THE GOVERNOR COULDN'T GET INTO HIS
TWITTER ACCOUNT, HE LIVED OUT ONE OF MY
VERY SPECIFIC NIGHTMARES IN REAL LIFE.

Ok, I've got it, just need to plug in my security key. Hmm,
which way does the USB go? Nope, not that way. I'll just flip
it and- OH JEEZ IT FELL INTO THE VENT.

Explanation

On January 13, 2018, the state of Hawaii sent out an emergency alert warning of an incoming ballistic missile attack. The message was specifically noted to NOT be a drill. This caused widespread panic and fear amongst the island residents, and there were follow-up confirmations from local entities who thought the original warning was real. It was eventually determined that the alert was sent in error – the explanation being that a technician accidentally sent out the "real" version when they were supposed to be testing the system during an end-of-shift changeover – but the fact that it took around 15 minutes for the correction to be sent drew widespread criticism. On January 23, it was revealed that the governor of Hawaii knew the alert was a false alarm only two minutes after it was sent, but couldn't notify the public because he had forgotten the login information for his Twitter account.

The proliferation of online services requiring authentication, together with variations in security requirements, various flavors of Multi-factor authentication, a variety of password retrieval methods, and security advice not to re-use passwords across services, has resulted in the management and memorization of passwords becoming a major headache for many people. This comic shows Cueball, representing the governor, frantically trying to retrieve his log in to Twitter and encountering a number of common frustrations:

- He has a number of passwords that he uses, likely for multiple services, but none of them seem to be working. Often people will use subtly different variations of one or more password(s) for different logins since logins may require different password requirements. In a situation where they've forgotten the relevant password, this can lead to them cycling through all the possible variations, and struggling to keep track of which they have and haven't tried.
- He's requested a password reset, but doesn't know where to go to activate it. Many services allow users to reset a password using a link or information sent to them in an email. However, as many people have multiple email accounts, this can be unhelpful and frustrating if it simply indicates that 'you have been sent an email'.
- He expects the password to have been saved somewhere, but can't work out where. Many devices and browsers now have the facility to save and/or sync passwords entered through them, in an attempt to simplify their management by providing centralized storage. However, the very number of these available leads to a re-fragmentation.

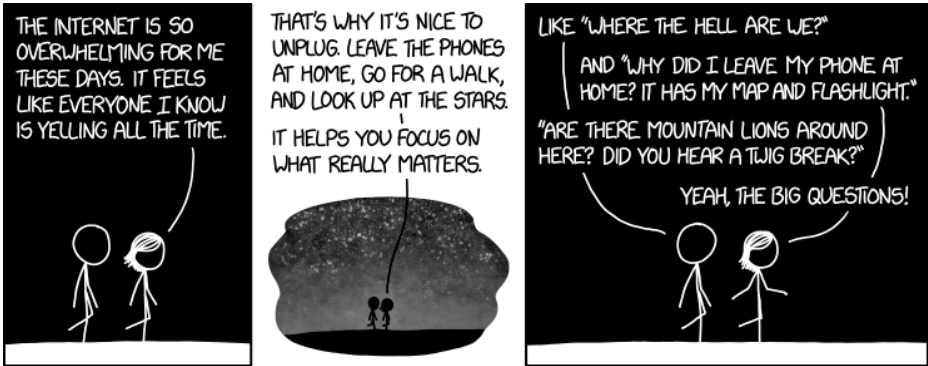
Off-panel, another person is adding to the stress of his situation by screaming at him that people are beginning to panic and warning sirens are going off, underscoring the need to get the correction out as fast as possible. As the caption under the comic indicates, Randall has had a nightmare along these (very specific) lines, and is amused to find someone experiencing that nightmare in the real

world.

The title text refers to USB security keys, physical USB devices that act as tangible 'passwords' for various accounts or devices. (A traditional key of shaped metal is literally a tangible password, with each digit of the password releasing one tumbler of a physical lock; Electronic keys replace the key-and-tumbler password system with a digital password signal.) In the context of this comic, the governor attempts to sign into his Twitter account using one such key, but can't insert it into his computer correctly (as USB devices are infamous for needing to be inserted in a particular orientation despite having a symmetrical outer appearance; also known as USB superposition.) Trying to flip the key around, Cueball drops it into a vent - similar to what happens in 1518: Typical Morning Routine.

#1947: Night Sky

January 26, 2018



There's a mountain lion nearby, but it didn't notice you because it's reading Facebook.

Explanation

With the increasing ubiquity of connected devices in people's lives have come concerns about the social and mental effects this is having. A common trend in lifestyle advice is the idea of "unplugging" and getting away from technology, with the idea that this can improve one's sense of well-being, and allow a focus on the important things in life, such as asking the "big" existential questions.

Cueball and Megan are taking one such activity: a nighttime walk without their phones. However, rather than being grandiose, the questions they ask are increasingly immediate to their current situation. Far from finding the experience liberating, they find it first frustrating, as they no longer have access to useful features of their phones, such as mapping with GPS, which would help them find their way, and a flashlight, which would let them see where they were going, and then unsettling, as without their devices to distract them they begin to imagine dangers, such as mountain lions, lurking in the darkness.

The fact that Megan enthusiastically affirms that those really are the "big questions" of life reveals that they are sarcastically teasing each other about their regrettable decision.

The reference to mountain lions might be related to the declaration that eastern cougars were officially declared

extinct the day before this comic was published.

The title text claims that technology is so omnipresent that even the threatening mountain lion has a phone and is reading Facebook (and, therefore, is not so threatening, since it now can not notice them). Alternatively, either Cueball or Megan might be teasing the other.

#1948: Campaign Fundraising Emails

January 29, 2018

1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> DONATE NOW. IT'S CRUNCH TIME, AND WE'RE LOW ON CASH. IF YOU CHIP IN JUST \$5 BY MIDNIGHT, WE...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> DONATE \$35.57 NOW! OUR DATA TEAM HAS DETERMINED THAT WE SHOULD ASK YOU FOR \$35.57 TO OPTIMIZE THE...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> HELP. OUR CAMPAIGN MADE SOME MISTAKES AND WE NEED A LOT OF MONEY ASAP. ANY KIND, BUT CASH IS...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> WASHINGTON IS BROKEN. WHEN I WIN, I'LL LOOK THOSE OTHER SENATORS IN THE EYE AND TELL THEM: "JOBS" THEN I...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> HOPELESS. IT'S BAD REALLY BAD. IF YOU DON'T CHIP IN NOW, THE DARKNESS SPREADING ACROSS THE LAND WILL...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> AS THE FIRST WOMAN TO FLY A FIGHTER JET THROUGH OUR STATE'S FORMERLY ALL-MALE UNIVERSITY, I LEARNED...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> WE'RE BROKE. NO PAID STAFF, NO ADS, AND THE CAFE HAS TOLD US TO STOP USING THEIR WIFI TO SEND FUNDRAISING...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> WHEN AMY DECIDED TO RUN FOR CONGRESS, I WAS LIKE "HUH?" BUT I CHECKED WIKIPEDIA, AND APPARENTLY IT'S A BRANCH OF...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> ARE YOU FAMILIAR WITH THE DUTCH PAINTER HIERONYMUS BOSCH? HIS WORK ILLUSTRATES MY OPPONENT'S PLAN FOR...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> BEING A SINGLE MOM RUNNING A SMALL BUSINESS WHILE GOING TO LAW SCHOOL WHILE DEPLOYED TO IRAQ TAUGHT ME...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> I WILL LEAD THE FIGHT AGAINST THE BIG BANKS, SPECIAL INTERESTS, THE EARTH'S CLIMATE, AND OUR CHILDREN. I...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> WOW. HAVE YOU SEEN THIS VIDEO OF THE SQUIRREL OBSTACLE COURSE? INCREDIBLE! ANYWAY, I'M RUNNING BECAUSE I...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> OUTRAGEOUS. GRANTED, THIS WAS A FEW YEARS AGO, BUT DID YOU HEAR WHAT PRESIDENT FORD SAID ABOUT...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> WHOOOPS. DUE TO A TYPO, WE SPENT MONTHS RUNNING ATTACK ADS AGAINST TOM HANKS. NOW, WE NEED TO MAKE UP FOR...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> THEY SAY WE CAN'T WIN—THAT WE'RE "UNDERDOGS" WITH "NO MONEY" WHO "LOST THE ELECTION LAST WEEK" BUT THEY DON'T...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> OUR CAMPAIGN'S ONLY CHANCE IS TO SEDUCE JENNIFER ACTBLUE, HEIR TO THE ACTBLUE FORTUNE. FOR THAT, WE NEED A FANCY...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> DOOM! WHERE IS THE HORSE AND THE RIDER? WHERE IS THE HORN THAT WAS BLOWING? THEY HAVE PASSED, LIKE RAIN ON...
1/29/18 10:23 AM - 1/29/18 10:23 AM	<input type="checkbox"/> WARMEST GREETINGS. I AM THE CROWN PRINCE OF NIGERIA. I AM RUNNING FOR CONGRESS BECAUSE I BELIEVE THAT...

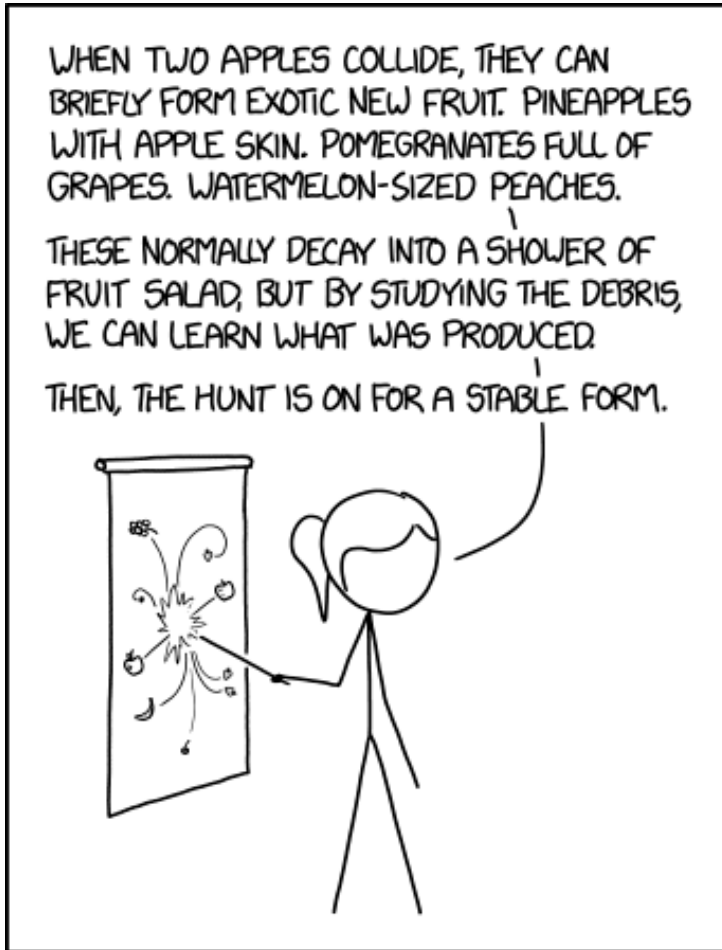
The establishment doesn't take us seriously. You know who else they didn't take seriously? Hitler. I'll be like him, but a GOOD guy instead of...

Explanation

Many politicians and organizations in the United States have taken to using email to conduct aggressive fundraising drives seeking campaign contributions. Signing a petition or expressing interest in a cause can lead to being added to a myriad of mailing lists for similar groups, all looking for support. This comic shows a caricature of the kind of inbox that can result from this. The emails get more and more absurd as the list goes on. For example, the last one combines a request for campaign contributions with the infamous 'Nigerian prince' advance-fee scam emails.

#1949: Fruit Collider

January 31, 2018



HOW NEW TYPES OF FRUIT ARE DEVELOPED

The most delicious exotic fruit discovered this way is the strawberry banana. Sadly, it's only stable in puree form, so it's currently limited to yogurt and smoothies, but they're building a massive collider in Europe to search for

a strawberry banana that can be eaten whole.

Explanation

Ponytail is suggesting that exotic new fruit can be created in a similar way to that in which exotic subatomic particles can, by smashing together more common varieties at high speed.

Particle accelerators are used to smash sub-atomic particles together at near-light speeds. This can result in a release of enough energy to produce massive exotic particles that do not exist under standard conditions. By examining the results, physicists can test theories in physics and, sometimes, unexpected consequences can force them to revise existing theories. When explaining particle accelerators to the general public, this kind of experiment is sometimes explained with a fruit analogy. For example, the University of Oxford's "Accelerate!" show says "It's like throwing together two apples really really hard and getting three bananas and a mango." In this comic strip, the analogy is taken literally, and claims that several interesting new types of fruit have been created.

The tough, spiny skin of pineapples makes them (almost) impossible to eat without a knife and, while high in fiber, can be a danger to the intestinal tract and is commonly considered inedible. Nevertheless, many people really like the taste of them. Creating a variety with the skin of an apple would allow them to be enjoyed without the usual inconvenience.

A pomegranate is a large berry containing a large number of seeds with fleshy coverings. Many people find the high seed-to-flesh ratio offputting when eating them. If these were replaced with grapes, this ratio would be much lower; if it were a seedless variety of grape, it could be zero.

This could be a reference to the Roald Dahl story James and the Giant Peach, or Randall may just really like peaches, as shown in 388: Fuck Grapefruit.

Strawberry and banana is a popular flavor combination for yogurts and smoothies. The "massive collider" in Europe refers to the Large Hadron Collider, the largest particle accelerator in the world. However the Large Hadron Collider was built to investigate the relationship between matter and forces, and not to search for a strawberry banana[citation needed].

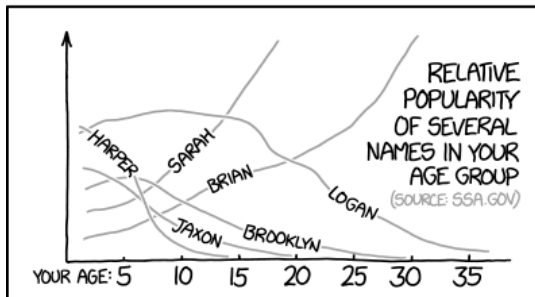
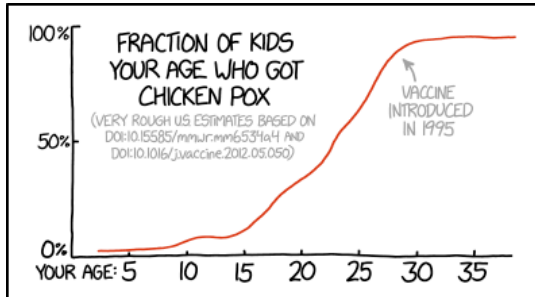
Many fruit-based snacks and drinks will derive flavors from fruit blends. These are generally created by mixing the juice, or artificial substitute flavorings, of two separate, individual fruits, rather than by attempting to create a new fruit by smashing the constituent fruits together. Some man-made hybrid fruits have been created via cross-breeding, grafting, and genetic engineering. It is notable that fruiting plants are generally far more capable of mixing genes across species than animals are. It is often quite possible to produce a hybrid of two fairly distantly related fruits by forcing the pollen of one to fertilize the ovary of another, or even splicing the bulk of the genes together. Of course, this would be

more likely to happen in a high-energy collision of their reproductive parts, rather than their fruits. Smashing two fruits together at high speeds will usually result in a sticky mess rather than a new fruit hybrid, as recognised in the title text.

It should be noted that the hypothesis presented in this strip has now been tested by The Slow Mo Guys.

#1950: Chicken Pox and Name Statistics

February 02, 2018



CHICKEN POX INCIDENCE BY NAME:
(VERY ROUGH ESTIMATE)

BRIAN:	75%
SARAH:	60%
LOGAN:	20%
BROOKLYN:	10%
JAXON:	4%
HARPER:	2%

FUN FACT: PEOPLE NAMED "SARAH" AND "BRIAN" THINK CHICKEN POX IS NORMAL AND COMMON, AND PEOPLE NAMED "LOGAN" AND "HARPER" DO NOT.

People with all six of those names agree that it's weird that we have teeth, when you think about it for too long. Just about everyone agrees on that, except-in a still-unexplained statistical anomaly-people named

"Trevor."

Explanation

This is another comic with one of Randall's fun facts.

In this comic statistics are used to point out some non-intuitive correlations. The first panel sketches out the prevalence of chicken pox by age in the United States.

As the graph indicates, prior to the introduction of the varicella vaccine in the United States, it was an exceptionally common childhood illness, with almost 100% of the population experiencing it at some point. The illness is highly memorable (since the symptoms last for days and are intensely uncomfortable) and noticeable (since the characteristic blisters are distinctive and difficult to hide), meaning that it was once a common experience that people expected to both experience and see in their peers.

As the vaccine became widespread in the US, rates of varicella infection declined dramatically, and new infections are now relatively uncommon. The graph points out that this has led to a fundamental shift in experiences by age. For an American over the age of 30, nearly all your peers growing up would have had chicken pox. For an American under the age of 10, virtually none of them would have had it. This means that older people are likely to think of chicken pox as a normal part of life, while children are likely to have no experience with it, and may not even know what it is.

The second, seemingly unrelated graph, charts the

popularity of certain names over time, in the US. It's normal and expected for certain names to rise and fall in popularity over time, which means that the number of people with those names ends up clustered by age. The names "Sarah" and "Brian" have gone from being highly popular to relatively uncommon for new babies, meaning that people with those names are much likelier to be older. Names like "Logan", "Brooklyn", "Jaxon" and "Harper" went from being virtually unused to having a spurt of popularity, meaning that (as of 2018) people with those names are much more likely to be under the age of 15 than over it.

The final panel points out that these trends, taken together, generate the interesting effect that you can, in some cases, estimate the odds of someone having had chicken pox, based solely on their first name. Having a name like "Brian" or "Sarah" raises the odds that you're over 30, which raises the odds that you had chicken pox. People named "Harper" or "Jaxon" are almost certainly young enough to have grown up with the vaccine in broad use. These time-based trends predict both the odds of a person having had the illness personally, and the odds that they grew up in a time when infections were common and generally expected.

The cartoon demonstrates the correlative fallacy, i.e. what can go wrong if one attempts to draw conclusions based on a random comparison of two variables, as described by the famous saying: "Correlation does not imply causation". In this case, there's a real correlation between names and the incidence of a particular disease.

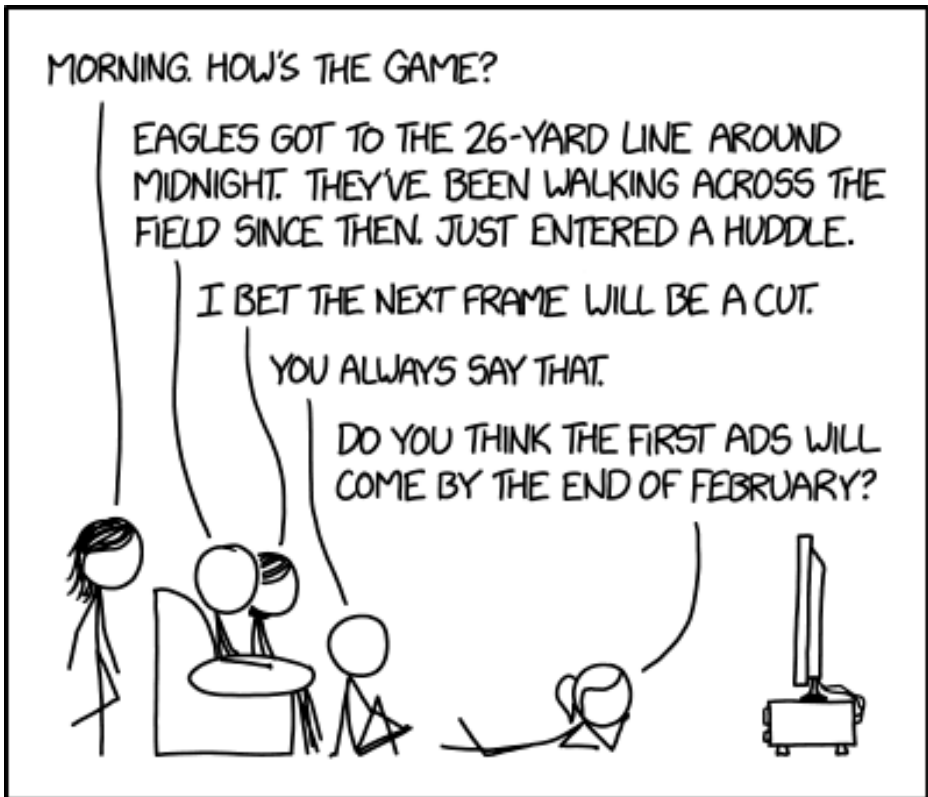
A superficial reading could suggest that either certain names make people prone to the disease, or that the disease, in some way, impacts a person's name. The real cause of this correlation is simply that certain trends just happen to coincide, causing them to statistically correlate without either variable having a real causal affect on the other.

The citations are real articles. The first citation DOI:10.15585/mmwr.mm6534a4 is on the Center for Disease Control (CDC) web site at www.cdc.gov/mmwr/preview/mmwrhtml/mm6534a4.htm and the second citation DOI:10.1016/j.vaccine.2012.05.050 is an article in Vaccine at www.sciencedirect.com/science/article/pii/S0924646012005050. Both articles describe the effects of the vaccine for varicella which is the virus that causes chicken pox and shingles (also known as herpes zoster).

The title text states that people with all six of the names in the last panel (and indeed, most people in general) tend to think that it's weird we have teeth after thinking about it for a while, but that people named Trevor don't in an unexplained statistical anomaly. Teeth are a normal and near-universal part of the human anatomy (and that of many other animals). Like many aspects of biology, they're generally taken for granted, but can seem "weird" if you think about them too much. Randall has often demonstrated a tendency to over-analyze typical aspects of life until they become troubling. Here, he jokes that people with one particular name don't experience this, for unexplained statistical reasons. This is, of course, fictional. The joke comes from the fact that, were that claim true, it would be as random and as hard to believe as the real phenomenon that the comic addresses.

#1951: Super Bowl Watch Party

February 05, 2018



I'M AT A YEAR-ROUND SUPER BOWL WATCH PARTY.
WE'RE PLAYING THE STREAM AT $\frac{1}{2300\times}$ SPEED, SO IT
WILL END JUST AS NEXT YEAR'S SUPER BOWL STARTS.

It's going to be weird near the end of May when the screen goes blank for over 18 hours.

Explanation

The Super Bowl is the annual championship game of the National Football League (NFL), the highest level of professional American football. In late January or early February each year, the winner of the American Football Conference (AFC) plays the winner of the National Football Conference (NFC) to determine the champion. In Super Bowl LII held on Sunday, February 4, (the day before this comic's release), the NFC champion Philadelphia Eagles defeated the AFC champion New England Patriots 41-33. Based on its wide-reaching cultural impact, the Super Bowl is the single most important American football game of the year. Over a hundred million people (across the world) watch it, many of whom are not even fans of American football.

Many people have parties centered on watching the game. The full game lasts around four hours, including breaks for advertisements and a halftime. The halftime show of the Superbowl includes a live musical performance, and is generally considered one of the most prestigious shows in the country, meaning it will generally be an elaborate show by a particularly popular artist or group. Because of the high viewership of the Superbowl, advertising time is very expensive (\$5 million for a 30-second national spot, as of 2019). This has led to companies putting substantial resources into producing the commercials, to make them as memorable as possible. The net effect is that the halftime show and the commercials, despite being interruptions to the game,

have become attractions in their own right, with some viewers tuning in primarily, or even solely, to watch them.

Cueball and Megan (on the couch) have such a Super Bowl Watch Party going with their friends (hence the title), but in order to watch the game so that the end will be at the start of the next game, they have slowed down the broadcast so the game takes an entire year to watch. Television in the United States is broadcast at 29.97 frames per second. The 2018 Super Bowl was 3 hours and 46 minutes long, for a total of 406,393 frames. But by slowing the video down by a factor of 2300, the Super Bowl would last a full year. Each frame would be shown for about 76.7 seconds. Each day of watching the slow video would cover just under 40 seconds of "actual" time. With this method of viewing, the watchers are instead reduced to analyzing the game frame-by-frame, which may make it easier to understand the sequence of events, but also creates a feeling of tedium.[citation needed]

Due to this extension creating a lack of variety, Megan tries to make it interesting by guessing the next frame shown will be a cut to a different camera angle. Cuts happen frequently during the broadcast, especially when the ball is not in play, and these cuts may be marked by a black screen. If this is the case, then the cut will be around a minute of nothing to look at at this speed. Megan has a relatively high probability (albeit still incredibly low, with cuts being less than one in every 1000 frames) of being right simply by chance that the next frame will be a cut, but Cueball's tired comment

that she always guesses that indicates that the game is so slow or the cuts are so rare that she is almost never correct.

Ponytail asks if they think the first ad block will come out before the end of February, about 20 days after the start of the Super Bowl show. The ads and halftime show are considered integral parts of the broadcast, and many advertisers debut elaborate commercials especially for this game, since so many people watch it. Many people claim to watch the Super Bowl only for the commercial breaks, as mentioned in 60: Super Bowl, and the anticipation for these is exaggerated for this game, as the wait is much longer with the extended broadcast. (In exchange, however, the commercials will be longer, too.)

The title text refers to how, during a commercial break during the 2018 Super Bowl, only blackness was broadcast for 28 seconds due to equipment failure at NBC. At the rate they watch it would last almost 18 hours as described (17 hours 53 minutes).

In previous comics regarding the Super Bowl, Randall has explained that he now watches the Super Bowl (1480: Super Bowl), despite previously expressing a lack of interest in the game (60: Super Bowl) or any other sport (1107: Sports Cheat Sheet). A slowly updating video is similar to the concept behind 1190: Time, and is also reminiscent of Douglas Gordon's 1993 art installation 24 Hour Psycho. Also, As Slow as Possible is an organ piece that is currently played in a German church - it will end in 2640, after 639 years of continuous

playing. The theme of a group becoming interested in frame-by-frame shots is reminiscent of 915: Connoisseur. Related to frame-by-frame film watching is the Cinema interruptus concept used by film critic Roger Ebert at the Conference on World Affairs, where you first watch a film at normal speed, without interruptions, and then you watch it again, over several afternoons - while everybody present can stop the film at any time, and have a discussion about anything related to the scene. This is also a method that coaches use to discuss recordings of games.

#1952: Backpack Decisions

February 07, 2018



AMOUNT OF TIME I'VE SPENT PARALYZED
BY INDECISION OVER CHOOSING THE RIGHT...



"This one is perfect in every way, except that for some reason it's woven from a tungsten mesh, so it weighs 85 pounds and I'll need to carry it around on a hand cart."

"That seems like a bad--" **"BUT IT HAS THE PERFECT**

POCKET ARRANGEMENT!"

Explanation

Cueball, probably representing Randall, is having issues choosing a good backpack. He notices their different features and is indecisive. After presumably spending a long time choosing, he is able to narrow his choices down to two backpacks, only to discover that another backpack had the extra feature of being waterproof, a criterion he had not up to then been accounting for. This has made him more indecisive. Frustrated by the extra information load, he considers giving up on backpacks to take another look at messenger bags. Disregarding that thought, he decides to start over, evaluating all of the backpacks again considering the new information. Clearly he is spending a lot of time on this, and the chart below shows that he spends more time unsure of what backpack to pick than of any other major choice, such as a college or a car. This is unusual, since differences between backpacks impact one's life much less than those between colleges or cars.[citation needed]

A backpack and its features, or lack thereof, might impact a person on a more ongoing and intimate basis than a college choice (which, for Randall, was a long time ago) or a car (if your view of cars mainly concerns their function) in certain situations. A perfectionist technology geek, such as Cueball or Randall (as Cueball is implied to be) would likely remember, every time he used his backpack, the satisfaction of having found the perfect backpack, or the disappointment of being unable to do so.

The title text is Cueball having a conversation (or thinking to himself) about a backpack, which seems (absurdly) to be made of heavy tungsten mesh. In fact, at 85 pounds (39 kg), it is so heavy that Cueball thinks he will need to carry it around in a cart, defeating the purpose of the backpack. However, Cueball considers it simply because of the perfect pocket arrangement, which he cannot use anyway, due to the backpack's heaviness. The explanation about the pocket arrangement is written in all caps, indicating that Cueball is yelling from pure excitement at the pocket arrangement.

#1953: The History of Unicode

February 09, 2018



2048: "Great news for Maine—we're once again an independent state!!! Thanks, @unicode, for ruling in our favor and sending troops to end New Hampshire's annexation."

Explanation

This comic shows the creator of Unicode talking about how it would change the way we thought about managing text, which could help with incompatible binary text encoding. 30 years later, a tweet from Maine Senator Angus King highlights its evolution. King writes that he is excited for the addition of a new lobster emoji, displaying the more frivolous uses of the standard. His tweet is signed using two emoji to form his name, referencing the cattle breed called Angus cattle and the crown emoji. The tweet was released February 7th, only two days before the comic.

An encoding of a character set is a mapping from characters to numbers. For example, the letter "A" is represented by the value 65. At the time, some languages, such as Japanese, had several incompatible character encodings, which meant different characters could be represented by the same value. Unicode was developed to solve this by providing all the encodings for all the various characters used in the world's languages for a single character. Unicode is run by a consortium of major technology companies and stakeholders. The founders of Unicode include Joe Becker, who worked for Xerox in the 1980s. He has a beard and may be the character featured in the first and last panels of the comic.

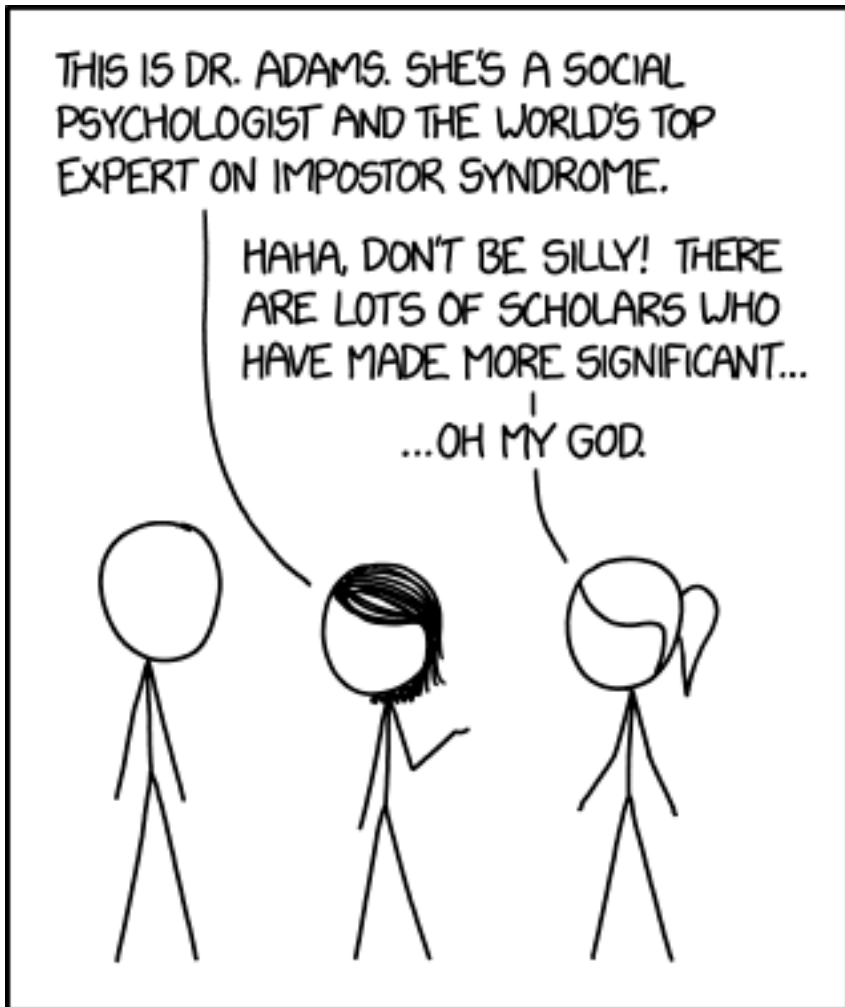
New characters have continued to be added to Unicode, and recently many "emoji" (picture characters) have been added. Emoji were originally added to be compatible

with text message encodings in Japan, but after devices in other countries started supporting them as part of Unicode, they caught on worldwide. Now emoji characters are added for their own sake, not just for compatibility. The lobster emoji, 🦞, was approved as part of Unicode 11, for release in 2018. This comic was published on February 10, 2018 .

The title text imagines that Unicode will gain other unexpected roles in the next 30 years. In particular it acts as an armed force, capable of intervening in military disputes, such as an annexation of Maine by its neighbour, New Hampshire. The title text ends with three Unicode emoji: 🧑 "PERSON WITH FOLDED HANDS", 🚁 "HELICOPTER", and 🏅 "MILITARY MEDAL", suggesting that they are thanking them for their effort in the war, sending helicopters and soldiers to aid them against New Hampshire. The phrase "we're once again an independent state" may also be a political pun, as 2048 should be an election year, and King is an independent senator.

#1954: Impostor Syndrome

February 12, 2018



It's actually worst in people who study the Dunning-Kruger effect. We tried to organize a conference on it, but the only people who would agree to give the keynote were random undergrads.

Explanation

Impostor syndrome is a common psychological phenomenon where successful individuals are unable to internalize their success and fear being exposed as a "fraud" or "impostor." Events and accomplishments that would seem to be evidence of competence, skill, intelligence, and so forth, are instead viewed (by the person) as luck, timing, and the ability to appear more confident/competent than they actually are.

Ponytail, representing Dr. Adams, is introduced by Megan as "the world's top expert on impostor syndrome." Dr. Adams then demonstrates that she herself (like a relatively large number of women according to some reports) is afflicted by this syndrome. She realizes this after she reacts to the flattering introduction by starting about "other scholars" whom she deems to be superior to her.

The Dunning–Kruger effect, mentioned in the title text, is a cognitive bias wherein people who possess comparatively little direct expertise in a given field may unrealistically inflate their estimation of their own level of expertise in that field; while those who actually are highly competent (and especially experts on the topic at hand) are likely to downplay their level of expertise. This cognitive bias arises when people of low relevant ability lack the practical knowledge to validly assess their competence: The criteria for good or poor performance in a given field may not be weighed accurately by

someone lacking direct expertise and formal training in that specific field. For instance, a commuter experienced in filtering through traffic quickly may consider themselves to be excellent at driving, while a professional evaluating driving habits may observe adherence to regulations and best practices for safety to be the primary criteria for being a "good" driver.

Conversely, people with extensive knowledge of a given field may develop an acute awareness of the necessarily limited scope of their (or any one person's) expertise. While this effect primarily refers to cognitive ability, it is also sometimes used to refer to people who are competent in one area (and thus not lacking metacognitive skills) believing that their abilities grant them unusually-high aptitude in a different but seemingly related area.

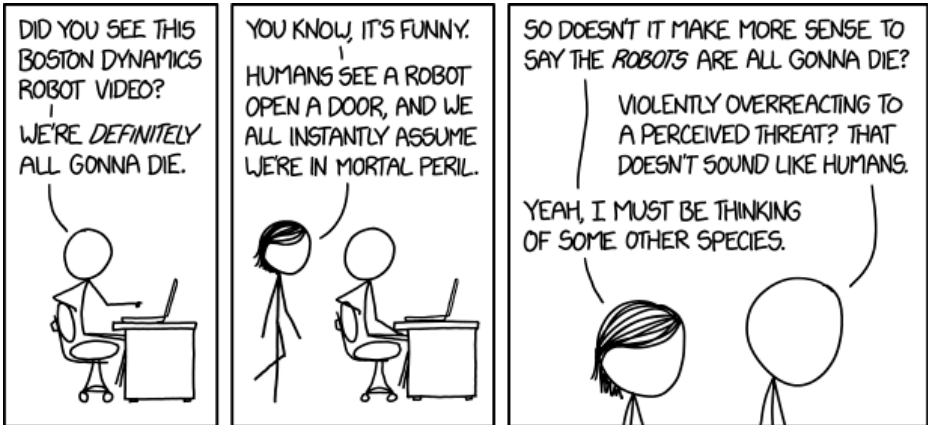
In practice, more expertise still largely correlates to higher confidence in one's expertise (that is to say that competence remains positively correlated with an individual's perception of their own competence), but a lack of the appropriate cognitive skills can result in that perception of competence starting at a high level yet increasing at a slower rate. However, in popular usage, the Dunning–Kruger effect is used to claim that a negative correlation exists, and that non-experts will claim expertise and confidence at a higher overall level than actual experts.

In the title text, a conference for the Dunning–Kruger effect was having trouble, presumably because the actual

researchers were downplaying their knowledge and expertise to the point where they refused to be the keynote speaker, while the random undergrads (who lack experience in the topic) felt sufficiently confident in their knowledge of it to give the keynote. This more closely matches both the secondary usage (as undergrads are unlikely to lack metacognitive skills, but may inflate their understanding) and the popular usage (as the confidence is inverse to the actual competence) than the primary and in-practice observance made in the original research.

#1955: Robots

February 14, 2018



Don't be nervous about the robots, be nervous about the people with the resources to build them.

Explanation

This comic refers to a YouTube video posted one day earlier by robotics company Boston Dynamics. The video shows a quadruped robot with a roughly canine form approach a door, then stop and 'look' to the side where a second robot appears, which has an articulated arm attachment on top. This robot sizes up the door, then uses its arm to grasp the handle and open the door. It holds the door open for the first robot, then follows it through the doorway.

The video was extremely popular, receiving over four million views in the first day. Many social media comments joked that humanity is doomed, as the robots we are developing will soon become capable enough to rise up and overthrow us. This is a common jest or anxiety expressed when robots manage to master a task that previously had given them difficulty. It is especially appropriate here, since the ability to open doors is extremely useful when dealing with humans. Randall has previously made the point that a robot uprising would promptly fail because most robots couldn't successfully open doors (or even successfully negotiate thresholds, in some cases). This latest advance seems to specifically undercut that assurance.

After Cueball sees this video, he reiterates the same line by saying that we're definitely going to die. Megan, however, offers an alternative view: that in fact, due to human nature, it is the robots that are in mortal peril

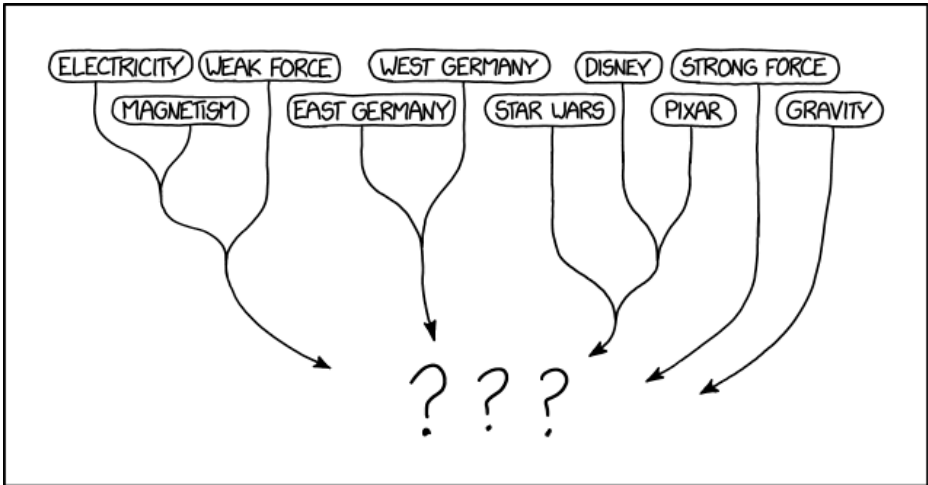
from this technological development, not humans, since humans tend to respond aggressively to potential threats.

Taking Megan's point, Cueball sarcastically suggests that humans don't tend to overreact violently to perceived threats, to which Megan replies, equally sarcastically, that she must be thinking of another species.

The title text may refer to the Mad Scientist or Evil Genius tropes in science fiction, where someone builds an army of robots with the intent of using them to take over the world. Alternatively, the title text could refer to the real life phenomena of military programs expending enormous resources to develop unmanned offensive capabilities, such as the Predator drone and SWORDS mobile weapon platform. In the latter context, it may be sensible to show concern with the methods, reasoning, motivations, and long-term stability of people directing the development of potentially lethal robots. Boston Dynamics is one of the foremost innovators in the field of military-grade automation.

#1956: Unification

February 16, 2018



PROGRESS TOWARD UNIFYING THE FUNDAMENTAL FORCES OF NATURE

For a while, some physicists worked on a theory unifying the other forces with both the force of gravity and the film "Gravity," but even after Alfonso Cuarn was held in a deep underground chamber of water for 10^{31} years he refused to sell his film to Disney.

Explanation

In physics, the fundamental interactions, also known as fundamental forces, are the interactions that do not appear to be reducible to more basic interactions. There are four fundamental interactions known to exist: the gravitational and electromagnetic interactions, which produce significant long-range forces whose effects can be seen directly in everyday life, and the strong and weak interactions, which produce forces at minuscule, subatomic distances and govern nuclear interactions. Some scientists speculate that a fifth force might exist, but, if so, it is not widely accepted nor proven.

This comic lists five physical forces (it split up electricity and magnetism), but also includes a number of other things (two countries and three businesses) that are known for "unifying" in a non-physics sense. East and West Germany united politically in 1990, more than forty years after being divided at the end of World War II. Entertainment company Disney has united in a business sense with a number of others over the years; the comic mentions animation studio Pixar and the Star Wars franchise. The comic states that this is the progress toward unifying the fundamental forces of nature, which is absurd, with the addition of Disney and Germany, neither of which is one of the fundamental forces.[citation needed] Star Wars is, of course, all about The Force, but this has, for some reason, gone unnoticed by most physicists.

The title text jokes that some physicists tried to unify the force of gravity with the 2013 movie Gravity, starring Sandra Bullock. Of course, this is also absurd, but it turns out that this is just another jab by Randall at George Lucas for selling his rights to Star Wars to Disney. The jab comes when he makes it clear that the director of Gravity Alfonso Cuarón would refuse to sell the rights to his film to Disney, even if he was held in underground chamber of water for 1031 years.

This water chamber and incredible time span is a reference to Proton decay, which is being investigated by trying to detect the Cherenkov radiation that could occur from possible decay of protons in water. These measurements are being conducted in immense water tanks buried under mountains to protect them against similar signals that could result from cosmic radiation. The same type of tanks have been used to detect neutrinos.

The half life of protons is currently believed to be between 1031–1036 years. This should be compared to the age of the universe at around 1.3×10^{10} years, which means that one second compared to the age of the universe is larger than the age of the universe compared to the smallest suggested half life of the proton (as used in the comic) by a factor of about 10,000, but even this time would not make Cuarón cave in...

Unifications[edit]

#1957: 2018 CVE List

February 19, 2018

LEAKED LIST OF MAJOR 2018 SECURITY VULNERABILITIES

- CVE-2018-????? APPLE PRODUCTS CRASH WHEN DISPLAYING CERTAIN TELUGU OR BENGALI LETTER COMBINATIONS.
- CVE-2018-????? AN ATTACKER CAN USE A TIMING ATTACK TO EXPLOIT A RACE CONDITION IN GARBAGE COLLECTION TO EXTRACT A LIMITED NUMBER OF BITS FROM THE WIKIPEDIA ARTICLE ON CLAUDE SHANNON.
- CVE-2018-????? AT THE CAFE ON THIRD STREET, THE POST-IT NOTE WITH THE WIFI PASSWORD IS VISIBLE FROM THE SIDEWALK.
- CVE-2018-????? A REMOTE ATTACKER CAN INJECT ARBITRARY TEXT INTO PUBLIC-FACING PAGES VIA THE COMMENTS BOX.
- CVE-2018-????? MYSQL SERVER 5.5.45 SECRETLY RUNS TWO PARALLEL DATABASES FOR PEOPLE WHO SAY "S-Q-L" AND "SEQUEL"
- CVE-2018-????? A FLAW IN SOME x86 CPUs COULD ALLOW A ROOT USER TO DE-ESCALATE TO NORMAL ACCOUNT PRIVILEGES.
- CVE-2018-????? APPLE PRODUCTS CATCH FIRE WHEN DISPLAYING EMOJI WITH DIACRITICS.
- CVE-2018-????? AN OVERSIGHT IN THE RULES ALLOWS A DOG TO JOIN A BASKETBALL TEAM.
- CVE-2018-????? HASKELL ISN'T SIDE-EFFECT-FREE AFTER ALL; THE EFFECTS ARE ALL JUST CONCENTRATED IN THIS ONE COMPUTER IN MISSOURI THAT NO ONE'S CHECKED ON IN A WHILE.
- CVE-2018-????? NOBODY REALLY KNOWS HOW HYPERVISORS WORK.
- CVE-2018-????? CRITICAL: UNDER LINUX 3.14.8 ON SYSTEM/390 IN A UTC+14 TIME ZONE, A LOCAL USER COULD POTENTIALLY USE A BUFFER OVERFLOW TO CHANGE ANOTHER USER'S DEFAULT SYSTEM CLOCK FROM 12-HOUR TO 24-HOUR.
- CVE-2018-????? x86 HAS WAY TOO MANY INSTRUCTIONS.
- CVE-2018-????? NUMPY 1.8.0 CAN FACTOR PRIMES IN $O(\log N)$ TIME AND MUST BE QUIETLY DEPRECATED BEFORE ANYONE NOTICES.
- CVE-2018-????? APPLE PRODUCTS GRANT REMOTE ACCESS IF YOU SEND THEM WORDS THAT BREAK THE "I BEFORE E" RULE.
- CVE-2018-????? SKYLAKE x86 CHIPS CAN BE PRIED FROM THEIR SOCKETS USING CERTAIN FLATHEAD SCREWDRIVERS.
- CVE-2018-????? APPARENTLY LINUS TORVALDS CAN BE BRIBED PRETTY EASILY.
- CVE-2018-????? AN ATTACKER CAN EXECUTE MALICIOUS CODE ON THEIR OWN MACHINE AND NO ONE CAN STOP THEM.
- CVE-2018-????? APPLE PRODUCTS EXECUTE ANY CODE PRINTED OVER A PHOTO OF A DOG WITH A SADDLE AND A BABY RIDING IT.
- CVE-2018-????? UNDER RARE CIRCUMSTANCES, A FLAW IN SOME VERSIONS OF WINDOWS COULD ALLOW FLASH TO BE INSTALLED.
- CVE-2018-????? TURNS OUT THE CLOUD IS JUST OTHER PEOPLE'S COMPUTERS.
- CVE-2018-????? A FLAW IN MITRE'S CVE DATABASE ALLOWS ARBITRARY CODE INSERTION. [~~~CLICK HERE FOR CHEAP VIAGRA~~~]

CVE-2018-?????: It turns out Bruce Schneier is just two mischevious kids in a trenchcoat.

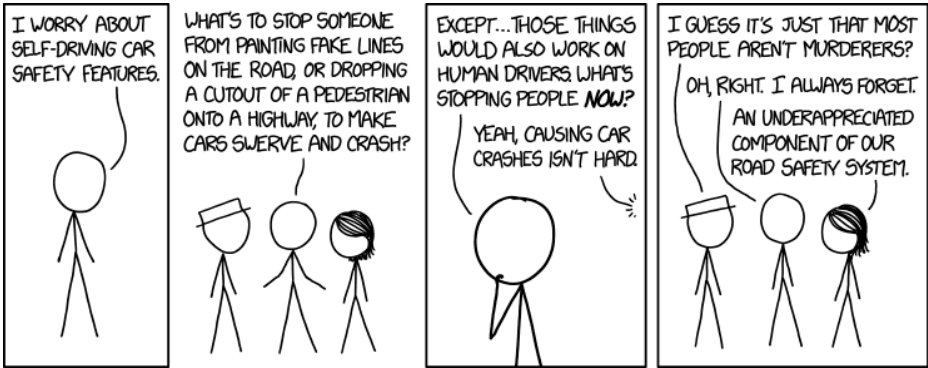
Explanation

CVE (Common Vulnerabilities and Exposures) is a standardized format for assigning an identity to a cybersecurity vulnerability (similar to the way that astronomical bodies are assigned unique identifiers by committees). Giving vulnerabilities a unique identifier makes them easier to talk about and helps in keeping track of the progress made toward resolving them. The typical format of a CVE identifier is CVE-[YEAR]-[NUMBER]. For example, the CVE identifier for 2017's widespread Meltdown vulnerability is CVE-2017-5754. CVEs also contain a short description of the issue.

In this comic (released in February 2018), Randall presents a number of spurious predicted CVEs for later in 2018. Each CVE identifier is given as "CVE-2018-?????", reflecting the fact that they have not yet happened so we don't know exactly what their CVE identifier will be. He has previously referenced diacritics in 1647: Diacritics. Bruce Schneier was previously mentioned in the title texts of 748: Worst-Case Scenario and 1039: RuBisCO. Here are short descriptions of all the vulnerabilities mentioned in the comic:

#1958: Self-Driving Issues

February 21, 2018



If most people turn into murderers all of a sudden, we'll need to push out a firmware update or something.

Explanation

Cueball explains being worried about self-driving cars, noting that it may be possible to fool the sensory systems of the vehicles. This is a common concern with AIs; since they think analytically and have little to no capability for abstract thought, they can be fooled by things a human would immediately realize is deceptive.

However, Cueball quickly assumes that his argument actually doesn't hold up when comparing AI drivers to human drivers, as both rely on the same guidance framework. Human drivers follow signs and road markings and must obey the laws of the road just as an AI must. Therefore, an attack on the road infrastructure could impact both AIs and humans. However, humans and AIs are not equally vulnerable. For example, a fake sign or a fake child could appear to a human as an obvious fake but fool an AI. A creative attacker could put up a sign with CAPTCHA-like text that would be readable by humans but not by an AI.

Cueball further wonders why, in this case, nobody tries to fool human drivers as they might try to fool an AI, but White Hat and Megan point out that most road safety systems benefit from humans not actively trying to maliciously sabotage them simply to cause accidents.[citation needed]

The theme of human fear and overreaction to the advent of more or less autonomous robots also features in 1955:

Robots. Self-driving cars is a recurring subject on xkcd. A variation on the idea that humans are mentally "buggy" is suggested in 258: Conspiracy Theories, though in that case divine intervention is requested to implement the "firmware upgrade".

The title text continues the line of reasoning, noting that if most people did suddenly become murderers, the AI might be needed to be upgraded in order to deal with the presumable increase in people trying to cause car crashes by fooling the AI - a somewhat narrowly-focused solution given that a world full of murderers would probably have many more problems than that. As Megan sees humans as a 'component' of the road safety system, it might also be suggesting a firmware update for the buggy people who have all become murderers, one that would fix their murderous ways. We are not currently at a point where we can create and apply instantaneous firmware updates for large populations; even combining all the behavioral modification tools at our disposal -- psychiatry, cognitive behavioral therapy, hypnosis, mind-altering drugs, prison, CRISPR, etc. -- is not enough to perform such a massive undertaking, as far as we know. The update might be about the car's firmware since it can be used to disable the brakes and thus causing or preventing many deaths.

#1959: The Simpsons

February 23, 2018

FUN FACT:

	1990	2018
LISA	8	36
BART	10	38
HOMER & MARGE	36-ISH	64-ISH

IF YOU WERE BART AND LISA'S AGE DURING THE FIRST FEW SEASONS OF THE SIMPSONS, THIS YEAR YOU'RE THE SAME AGE AS HOMER AND MARGE.

In-universe, Bart Simpson and Harry Potter were the same age in 1990. Bart is perpetually 10 years old because of a spell put on his town by someone trying to keep him from getting his Hogwarts letter.

Explanation

This is another comic with one of Randall's fun facts. It is a commentary on the longevity of the TV show The Simpsons.

The Simpsons is an American animated sitcom centered on the lives of the fictitious Simpson family. It is a very long-running series, having started with a Christmas episode in 1989, with the rest of the first season airing in 1990. As of the publication of this strip, it is still in production, having been on the air for 28 years with the same characters and primary cast. The decision was made early in the series that the characters wouldn't age, meaning that the parents, Homer and Marge, remained perpetually in their mid-thirties. The three children, Bart, Lisa, and Maggie, have remained 10, 8, and 1 year old, respectively. However, this has not stopped the writers from rooting specific moments of character's backstories in specific moments in time, such as Homer being old enough to witness the 1969 Lunar landing. One of the interesting impacts of this dynamic is that the audience and the world have significantly aged over the course of the show, but the characters remain the same age. A rather dramatic example is that many of the early fans were similar in age to the children, but have now grown up, many have married and had children of their own, and they are now closer in age to the parents.

The title text further relates this to the Harry Potter series, providing an explanation for why nobody has

aged. Harry Potter is the protagonist in a series of young adult novels (later adapted into films) about the adventures of a boy wizard in his magical school, Hogwarts. The series begins when Harry is accepted to Hogwarts, at age 11, and the timeline implies that he was born in 1980. When "The Simpsons" began, Bart was 10, implying he was also born in 1980 (although, in another case of "fixed timeline events", Bart is supposed to have been conceived after Homer and Marge saw *The Empire Strikes Back* during its theatrical run, which points to a birthdate sometime in early 1981). Unlike Bart Simpson, Harry and his compatriots explicitly age over the course of the series. This strip ties the two series together, joking that the lack of aging in the Simpsons is a result of magic from the Harry Potter universe, intended to stop Bart from ever turning 11, for fear that he'd be accepted to Hogwarts.

#1960: Code Golf

February 26, 2018

```
define callMeIshmaelSomeYe  
arsAgoNeverMindHow  
LongPrecisely():  
return 0  
define havingLittleOrNoMon  
eyInMyPurseAndNoth  
ingParticular(toIntere  
stMeOnShoreIThought  
IWouldSail):  
return 1 + toInterestM  
eOnShoreIThoughtIW  
ouldSail  
define aLittleAndSeeTheWat  
eryPartOfTheWorld(
```

MY HOBBY:
REVERSE CODE GOLF

I also enjoy Reverse Regular Golf. I've been playing for years all across the country and I'm still on the first hole.

Explanation

This was the first comic in the My Hobby series in over a year. It directly followed the second Fun fact comic in the same month, 1959: The Simpsons, after more than two years break from that series. It seems that Randall returned to his old themes this month.

Code golf is the attempt to use as few characters as possible to write a computer program with a certain function, analogously to regular golf's goal of getting the ball into the hole with as few strokes as possible. Reverse code golf would be to write a given program, probably to achieve a trivial outcome, using as many characters as possible. Randall's approach to this in the code example shown in the comic is to create overly long function names, using the beginning lines of Herman Melville's notoriously long-winded whaling novel Moby-Dick. Regular code golf also results in names of functions and variables that have nothing to do with their purpose in the program, but would minimise their length.

Using "as many characters as possible" to produce code is known as "Code Bowling" in the code golf space. Code bowling challenges usually come the requirement of being "pristine" meaning every substring of the code is necessary, and also often have restrictions on whitespace and identifier length. Without these restrictions it would be a trivial task to make any given program longer by inserting useless code or comments. Furthermore, some programming languages place no limit on function

names, so these could simply be made longer. The program listed here would not meet the requirements of most challenges. The code is written in a programming language that looks similar to Python, but with the keyword “define” instead of “def” to define functions. Python has no limit for function name length, and was previously featured in comic 353: Python.

The first two functions defined implement “zero” and “successor”, the two basic operations of Peano arithmetic. Presumably, the programmer will next implement natural number addition, then integers, then whichever branches of mathematics the original problem needs, all from scratch. Generally, you would use built-in functions to perform mathematical operations, so it is redundant to implement them yourself from scratch.

The title text suggests that Randall has also invented a reverse version of regular golf, where the aim is to take as many strokes as possible to get the ball in the hole. Similarly to Reverse Code Golf, the only challenge here would be the player's own boredom threshold, since they could always add more strokes by tapping the ball in a direction other than that of the hole.

Alternatively, he actually plays golf in reverse, starting from the hole (or pin) and hitting the ball towards the tee (he may or may not also be playing in the opposite direction of the hole layout established by the organisation which manages the course). This would however, be a flagrant violation of the Laws and Customs of Golf, as it interferes with other players'

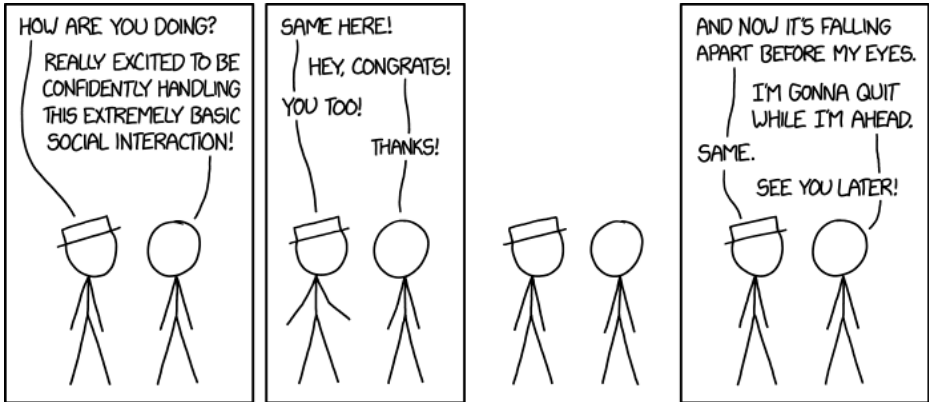
games and some aspects are impossible or unpractical (if Randall takes the view that the ball should start in the hole, the rules prohibit using any clubs to remove it in that it would damage the hole, and he would have to putt off the green).

The comment that he has "been playing for years all across the country and [is] still on the first hole" is ambiguous. Normally, when a golfer says they have been playing all across the country they mean that they have played rounds at many different courses. Randall could be implying the same, but that he's never finished the first hole (which, as noted above, would hardly be surprising), and so still counts it as playing one continuous first hole. Alternatively, he may literally mean that he has been playing the ball continuously across the whole country. Under normal golf rules this would result in his shots going "Out of Bounds" when it went beyond the boundaries of the original course. In one way, this would help him, as he would incur a penalty stroke. However, he would then have to play his next shot from the same spot as the last one, which would hamper him from continuing to play across the country. Since Randall has invented the sport, though, he may have chosen not to include Out of Bounds rules.

Interestingly, the comic ends with an unmatched left parenthesis (something which might be intended to create unresolved tension.

#1961: Interaction

February 28, 2018



[They do not move.]

Explanation

Cueball and White Hat are attempting to make small talk. White Hat begins the conversation with a typical greeting, asking, "How are you doing?" Normally this is a habitualized greeting pattern, where the person being greeted would respond with a generic positive like, "Good," "Okay," "Can't complain," etc. Instead, Cueball answers with a very open and honest statement about the social anxiety he thinks he is successfully dealing with. White Hat then admits that he is experiencing the same thing, and the two congratulate each other for having a "normal" conversation with another human. After that, there is an awkward silence where neither knows what to talk about next. Finally, White Hat makes note of the awkwardness and Cueball suggests they stop before it gets worse.

The scene is ironic because their dialogue mirrors the common pattern of typical minor daily interactions, but also differs greatly from anything "normal." White Hat & Cueball are being really weird here, specifically because their dialogue is inappropriately open & honest. The literal semantic content of their dialogue is probably more accurate & meaningful than the usual pleasantries people exchange, but the effect is very different.

So basically they have not managed to behave like regular human beings, and thus have nothing to congratulate each other for. Except for White Hat's opening line nothing in the conversation has in any way resembled

normal behavior. Due to their serious issues with small talking and interacting with other people, even this simple interaction fails completely, hence the title of the comic.

The title text states that, after saying goodbye, they don't move away, keeping up the uncomfortable silence, continuing to display their problems. Neither of them wish to be the first to turn away, or one or both are locked in the situation and has no clue how to finish it, even though they are both obviously aware of their problems and what makes them anxious. This may be a reference to the final stage direction "They do not move." in Samuel Beckett's play *Waiting for Godot*, where the protagonists frequently discuss leaving, but do not move.

Randall has previously made several comics with a similar theme, showing Cueball's (or his own) problems with several social situations / interactions / small talk, especially the comic 222: *Small Talk* which is very similar to this one. He made three of those type of comics in a span of about a month more than two years ago finishing with 1650: *Baby*.

#1962: Generations

March 02, 2018

"GENERATIONS" ARE ARBITRARY. THEY'RE JUST LABELS
WE USE TO OBLIQUELY TALK ABOUT CULTURAL TRENDS.

BUT SINCE PEW RESEARCH HAS BECOME THE
LATEST TO WEIGH IN, AND EVERYONE LOVES A
GOOD POINTLESS ARGUMENT OVER DEFINITIONS...

XXCD PRESENTS A DEFINITIVE CHRONOLOGY OF THE GENERATIONS

1730-1747 THE FOUNDERS
1748-1765 GENERATION f
1766-1783 THE ADEQUATE GENERATION
1784-1801 GENERATION AE
1802-1819 THE GENERATION WE CUT A LOT OF
SLACK BECAUSE THEY PRODUCED LINCOLN
1820-1837 THE GILDED GENERATION
1838-1855 THE SECOND-GREATEST GENERATION
1856-1873 GENERATION -...-
1874-1891 THE KIDS WHO DIED IN THE GILDED
GENERATION'S FACTORIES AND MINES
1892-1909 OOPS, ONE OF US IS HITLER
1910-1927 THE GREATEST GENERATION
1928-1945 THE SILENT GENERATION
1946-1963 BABY BOOMERS
1964-1981 GENERATION X
1982-1999 MILLENNIALS
2000-2017 GENERATION 🍷
2018-2035 ZUCKERBERG'S ARMY
2036-2053 THE HOVERING ONES
2054-2071 SPARE PARTS
2072-2089 MORE GEN-XERS SOMEHOW
2090-2107 THE PAPERCLIP MACHINES
2108-2125 THE MIXED BAG (PRODUCED 4 LINCOLNS,
1 NAPOLEON, AND 2 HITLERS)
2126-2143 THE PROCEDURAL GENERATION
2144-2161 GENERATION Ω
2360-2378 STAR TREK: THE NEXT GENERATION

For a while it looked like the Paperclip Machines would destroy us, since they wanted to turn the whole universe into paperclips, but they abruptly lost interest in paperclips the moment their parents' generation got into

making them, too.

Explanation

This comic is making fun of the various names we give "generations" while also predicting some future names. The release of this comic coincides with the Pew Research Center's recent announcement that they have decided where the Millennial generation ends.

Each generation listed is exactly 18 years long, which is the approximate length of each "generation" anyway (given that coincidentally, there are exactly 54 intermediate years between the end of World War II and the New Millennium). A number of the entries are parodies of the terms "Generation X," "Generation Y," etc., by substituting other letters or characters that would seem emblematic of the time period.

In the title text Randall suggests that the generation of paperclip-creating superintelligences will be weirded out when their parent generation starts making them too. (A parent generation in AI is the last set of separate algorithms trained on the sample before the last.) The implication is that their "parents" attempting to join in on converting all matter into paperclips will make the process seem outdated and uncool by association; a comparison could be drawn to, for example, Facebook losing younger users as it gains older users.

#1963: Namespace Land Rush

March 05, 2018

NAMESPACE LAND RUSH CHEAT SHEET

WHEN A NEW SERVICE APPEARS THAT LETS YOU REGISTER A NAME, HERE ARE SOME YOU MAY WANT TO TRY TO GET FIRST:

<u>STRAIGHTFORWARD</u>		<u>RECOGNIZABLE</u>	
<YOUR USUAL USERNAME, IF ANY>		GOOGLE	IPHONE
<YOUR GIVEN NAME>		FACEBOOK	BITCOIN
<YOUR FULL NAME>		OBAMA	CANADA
<INITIAL><SURNAME>		NFL	GARFIELD
<SURNAME> (BOLD & SLIGHTLY UNCONVENTIONAL)		<YOUR CITY>	NASA
		<NAME OF PERSON WHO RUNS THE SERVICE>	
<u>CAUSING TROUBLE</u>		<u>IMPOSSIBLE TO SAY</u>	
USER		HYPHEN-EMDASH	
USERNAME		DASH-8HYPHEN-8	
NAME		ZEROONE2NUMERAL2	
YOU		KRISASINHEMSWORTH	
GUEST		THEWORD&ERSAND	
ACCOUNT		ZETTAWITH3TEES	
<u>CAUSING MORE TROUBLE</u>			
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NARRATOR	INTERNET	SYMBOL>YES, THAT WAS ALL PART OF THE	
NPC	PASSWORD	NAME, BUT SO IS...OK, LET ME START OVER"	

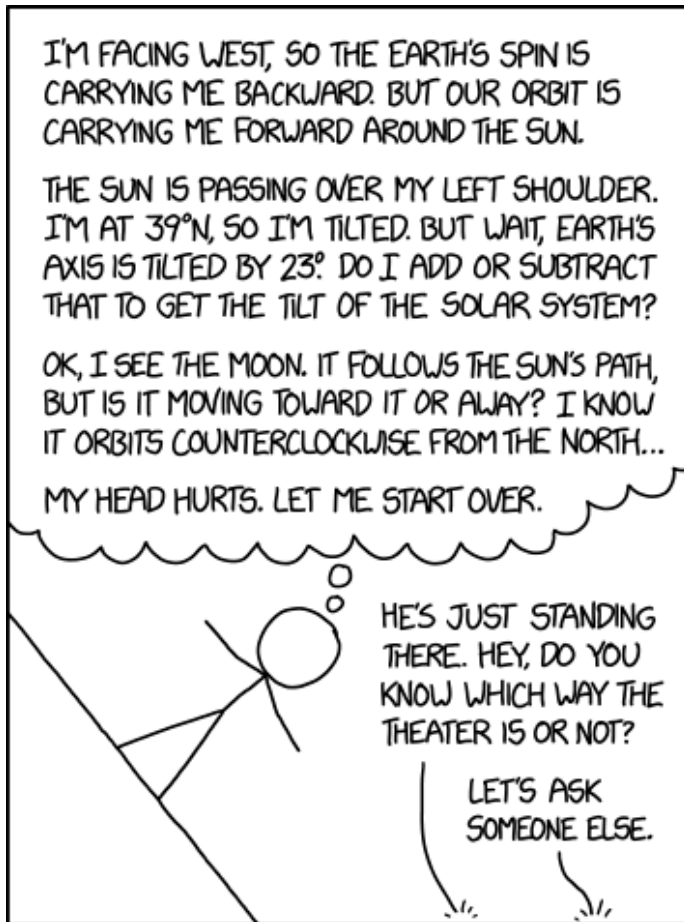
You can also just mash the keyboard at random, but you might end up with a gibberish name no one can pronounce.

Explanation

Explanation section not found.

#1964: Spatial Orientation

March 07, 2018



I SPEND WAY TOO MUCH TIME TRYING TO WORK OUT MY ORIENTATION RELATIVE TO OTHER STUFF IN THE UNIVERSE.

Here, if you know the number of days until the vernal equinox, I can point you to the theater using my pocket Stonehenge.

Explanation

Location in space is always relative, as we cannot observe empty space itself and find an absolute location. Planets are subject to different types of motion, including rotation, precession, and others.

Cueball starts by stating that as he is facing west, the Earth's spin will be carrying him backwards. Except at the poles, everything on Earth's surface is being rotated to the east, "toward" the rising Sun in the east or "away" from the setting Sun in the west.

On the equator, Earth's spin is about 464 meters per second (with 464 m being $1/60$ of $1/60$ of $1/24$ of Earth's equatorial circumference of 40070 km, based on the number of seconds in a day, ignoring the difference between sidereal and ephemeris days). So, on the equator at sunrise, on the day of a March or September equinox, this spin, by itself, would take someone toward the Sun at about 464 meters per second.

This spin would be slower than 464 m/s at 39 degrees North. The average radius of the Earth is 6371 km. This means that the distance from a line between the poles through the center of the Earth to a point on Earth's surface at 39°N is approximately 6371 km times the cosine of 39° (0.68 radians), which is 4951 km. So, the distance around the Earth along the 39° latitude "line" is 2π times 4951 km, which is about 31,109 km. (This estimate ignores the oblateness of the Earth.) The

rotation of the Earth on its axis would transport points on Earth at 39° latitude to the east at 360 meters per second (1/60 of 1/60 of 1/24 of 31,109). Determining how the direction that is currently east for Cueball is oriented relative to the Sun and the solar system depends on some of the issues Cueball identifies later.

Cueball then seemingly corrects himself in his head, having accounted for the fact that the Earth is also revolving around the Sun.

The Earth's orbit around the Sun is counter-clockwise, when viewed from above the North Pole looking down. Earth's counterclockwise orbit around the Sun means that, for most latitudes, the direction the Earth is moving around the Sun corresponds roughly to west at noon, and east in the middle of the night. The Earth is spinning, so "east" from any given location on the surface is not always the same direction relative to the Sun.

The speed of the Earth's orbit around the Sun depends on the time of year. The Earth moves faster around the Sun when it is closest to the Sun in early January, and slower when it is far away in early July (which may be counterintuitive to those in the northern hemisphere). However, Earth's average orbital speed is reportedly about 29.78 kilometers per second, with Earth's average distance from the Sun being a bit less than 150 million kilometers. Earth's orbit around the Sun is nearly circular, with an eccentricity of just 0.0167.

Cueball knows that the Earth's axis is tilted (by 23°)

relative to its orbit around the Sun and knows that he is 39° north of the equator, but is unsure how to combine this information to figure out his orientation relative to the plane of the solar system.

The Earth's orbit around the Sun, under Keplerian assumptions, is an ellipse, which lies within a plane. Furthermore, the entire solar system, to some extent, lies within a plane, since the orbital inclinations of Mars and the gas and ice giants are within $2\frac{1}{2}^\circ$ of Earth's and the orbital inclinations of a major body in the solar system (such as a planet) rarely, if ever, varies from that of another by more than 8° . With the exception of Eris, all planets and dwarf planets have an orbital inclination within about 30° of Earth's.

Cueball is attempting to determine where the plane of the solar system lies with regard to him. Ignoring any possible difference between Earth's orbit and this plane, and assuming that Cueball is standing on flat ground, the angle between the line from the center of the Earth through Cueball (which runs through his body parallel to his legs and spine if he is standing straight up) and the plane of the solar system can be expressed in terms of two angles: the angle between the plane of Earth's equator and the solar plane, and the angle between the Earth's equatorial plane and the vertical line through Cueball. Cueball is at 39°N , so if Cueball is standing straight up, the angle between the plane of the Earth's equator and the long axis of his body is also 39° . As stated in the comic, Earth's axis is currently tilted by about 23.4° (an amount which is very slowly decreasing as part of a

41,000 year cycle).

Cueball is trying to determine whether to add together 39° and 23° to get the angle between himself and the solar system's plane or subtract them. The answer depends on the time of day and the time of year. On the day of the summer solstice in the northern hemisphere (around June 21), the north pole is tilted toward the Sun, so at the longitude that is currently experiencing solar noon, the solar plane passes through a point that is 23° north of the equator. So, if it is solar noon on the summer solstice, Cueball should subtract the angles to find that the direction his body is pointing is roughly 16° away from the solar plane. If he were to somehow lean so that he could tilt his body 16° to the south, the solar plane would pass through the vertical axis of his body and his scalp would be pointed directly toward the Sun. On the other hand, on the day when the northern hemisphere is experiencing the winter solstice (around December 21), the northern hemisphere is pointing away from the Sun, so at solar noon on that day, he would add the angles together to find that his vertical stance is 62° away from the plane of the solar system. (The Sun is never truly directly overhead at latitudes further from the equator than 23.4° . At arctic latitudes that are less than 23.4° from the north pole – more than 67° north of the equator – the Sun is not visible on the day of the winter solstice even when it is noon.)

If it is not a solstice day, or if it is not noon, the calculations could become more complicated. The comic was uploaded roughly two weeks before the northern

hemisphere's spring equinox. Cueball notices that the Sun is "passing over his left shoulder" as he faces west. At temperate latitudes in the northern hemisphere, the Sun would be to the left of a person facing west around midday almost any time of year, although how many degrees to the left depends on the calculations discussed above.

An easier way to identify a line that is aligned with the solar plane would be to simply point directly at the Sun (without hurting his eyes). Since the distance between Cueball and the center of the Earth is minuscule compared to the distance between the Earth and the Sun, if he simply points directly at the Sun (preferably without looking directly at it), his arm and finger will be pointing in a direction that is basically parallel to the line connecting the Earth and Sun, which obviously lies on the plane of the Earth's orbit. The Earth's position will have changed minimally in the eight minutes it took the Sun's light to reach Earth, so the apparent direction to the Sun matches the actual direction. However, this will only provide one line that lies on the plane of the solar system and a line is insufficient to uniquely identify a plane.

Cueball knows about the Moon's path across the sky and knows that its orbit around the Earth appears counter-clockwise when viewed from above the North Pole, but is confused about whether the Moon is moving toward the Sun or away from it.

Like the Earth, the Moon, when viewed from above

Earth's North Pole, both orbits counterclockwise and rotates on its axis counterclockwise (with equal rotational periods such that the same side of the Moon always faces us). (In fact, almost every body in the Solar System both orbits the body it is orbiting counterclockwise and spins on its axis counterclockwise, with the rotational axes of Venus and Uranus being major exceptions.)

A new moon happens when the Moon is closer to the Sun than the Earth is, thus casting the near side of the Moon in darkness because it is the far side of the Moon that is facing the Sun. Conversely, a full moon happens when the Moon is on the other side of the Earth from the Sun; this is why a lunar eclipse can only occur during a full moon. In that sense, it could be said that the Moon is moving perpendicular to the line between it and the Sun at the time of the full moon and the new moon, moving toward the Sun after the full moon until the next new moon, and moving away from the Sun after the new moon until the next full moon.

In another sense, since the Moon is orbiting the Earth and the Earth's orbit around the sun is elliptical, it could be said that the Moon is getting closer to the Sun whenever Earth is moving toward its perihelion, the point in its orbit that is closest to the Sun, around January 2 to January 5, and moving away as the Earth moves toward its aphelion, the point in its orbit that is furthest from the Sun, around July 3 to July 6. (Yes, the Earth is closest to the Sun in January, despite what those in the northern hemisphere who are tilted away from the

Sun at that time may think.) In yet another sense, since the Moon follows the path of the Earth, and the Earth's orbit around the Sun is roughly circular, and the instantaneous motion of an object in a circular orbit is always perpendicular to the radius connecting it to the orbited body, it could be said that the Moon is always moving perpendicular to the line connecting the Earth and Sun, which is at most a fraction of a degree away from the line connecting the Moon and the Sun.

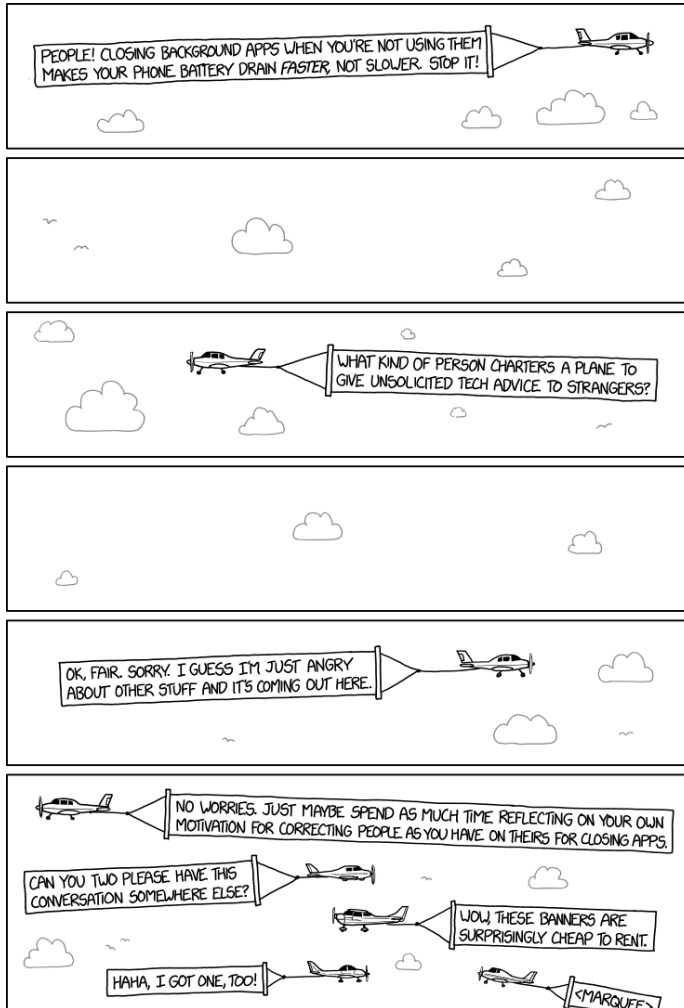
The semi-major axis of the Moon's orbit around the Earth (the furthest distance between the Moon and the center of its orbit) is 384,400 km. Compared to the semi-major axis of Earth's orbit around the Sun, which is 149,600,000 km, the axis of the Moon's orbit is only 0.26% as large. The Moon's orbital period is 27.3 days, but its synodic period (the time between full moons; the time it takes the Moon to reappear at the same point in the sky) is 29.5 days.

Cueball internally attempts to orient himself amidst the galactic chaos but is confused and has to restart. It is then revealed to the reader, that some passersby were only trying to ask Cueball for directions to the theater, and he was just grossly overthinking it. (A recurring theme in xkcd. See: 222: Small Talk, 439: Thinking Ahead, 1643: Degrees). One can imagine Cueball having his mind in astrophysics so much that he needs to calculate the angle of the road relative to the plane of the galaxy to determine which way a destination is in conversational terms.

In the title text, Cueball mentions he has a pocket Stonehenge. During the equinoxes the sun lines up with the actual Stonehenge's pillars. Assuming you were at the actual monument, armed with the date you could calculate the cardinal directions based on the Sun's location relative to the pillars.

#1965: Background Apps

March 09, 2018



My plane banner company gets business by flying around with a banner showing a `<div>` tag, waiting for a web developer to get frustrated enough to order a matching `</div>`.

Explanation

Background apps (apps in the recently used list) on both iOS and Android are in one of several paused states and do not usually consume much battery power; they only take up some memory. Closing them means that if you want to use the app again later, it will need to reload fully which likely uses up "very slightly" more battery. Wired had a detailed article on this topic a couple years ago. However, a much better reason to close the apps is to free up RAM/memory to make the programs run faster or even prevent them from crashing. Ultimately, whether or not you should close your apps depends on whether you prioritize battery lifetime or performance. (In Randall's case, low batteries tend to be something of a problem, and he references this in other comics as in 1373: Screenshot, 1802: Phone and 1872: Backup Batteries.)

The joke at first is that the misconception is so prevalent and irritating that a person would go to the trouble of renting a banner plane just to dispel it. However, the reasoning behind such an extreme action is then questioned by a second person, not only for the extreme measure of renting a plane but also for feeling the need to correct the misconception at all; however, following the internal logic of the comic, the second person also communicates via banner plane. (This is arguably hypocritical, as they themselves are chartering a plane for an equally, if not more, inane reason. Obviously, this would not happen in real life.[citation needed]) The first person responds, again via plane, once again just to

apologize to the second person and explain their actions.

At this point, the comic has left the initial joke about battery use entirely behind, and becomes a commentary about the logic of a world where people can converse via banner planes. In the final panel, the second person rents the plane yet again to respond to the first person's response, being no less smug or hypocritical than before. Meanwhile, four more people have chartered four different planes:

- One to urge the first two people to have their conversation somewhere private instead of flying planes with banners
- Another to comment on how surprisingly cheap the banners are to rent, thus explaining how the logic of the comic is possible in the first place
- A third just to show off their own banner
- A fourth displaying the opening part of the HTML `<marquee> "marquee" </marquee>` tag, a proprietary non-standard extension to HTML, now obsolete and deprecated tag that many web organizations advise against using, which is used to cause a message to scroll across the web page, much as the plane is flying across the sky.

The fairly obvious parallel here is to using various Internet forums for "unsolicited tech advice to strangers," smug responses, comments on others' advice, off-topic rejoinders, and all the other things that go on there constantly. It seems ludicrous to rent airplane banners

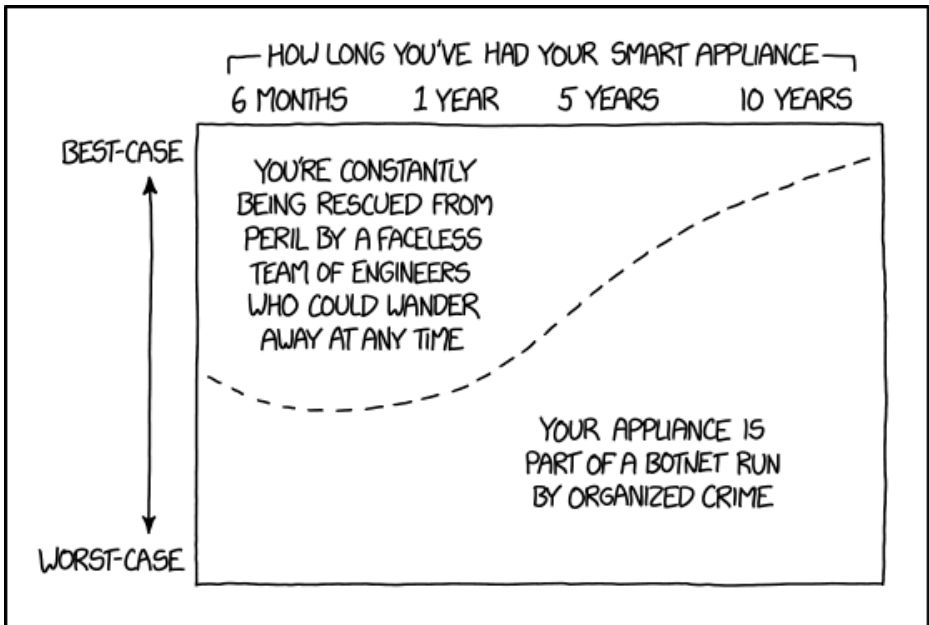
for such trivial purposes, but there are non-trivial resources involved in the global distribution of electronic communication, as well, and their use for purposes such as this seems ludicrous once Randall makes one think about it, and underlines that none of what is written on the banner may have anything to do with Randall's own opinions.

The title text is spoken by a plane banner company owner, who uses the insidious tactic of flying around with a banner of an unmatched HTML tag, just to compel obsessive people into renting banner space to make it syntactically correct. This may be a reference to 859: (or 1144: Tags.

The theme of the (mis)use of airplanes and banners has previously been explored in 1355: Airplane Message.

#1966: Smart Home Security

March 12, 2018



If they're getting valuable enough stuff from you, at least the organized crime folks have an incentive to issue regular updates to keep the appliance working after the manufacturer discontinues support.

Explanation

With the proliferation of smart appliances in recent years, there is a growing trend of hackers taking over smart "Internet of Things" devices and adding them to botnets. The hardware is then used for DDOS attacks, crypto mining etc. The "Mirai" botnet, for example, made of over 500,000 compromised routers, refrigerators, TVs, DVRs, baby monitors, thermostats, and webcams, was used in October 2016 to take down DynDNS, one of the core infrastructure providers for the internet in North America.

With the constant potential threat, security updates must be constantly published, and vulnerabilities must be found by the original developers and "white hat" hackers (the faceless team of engineers Randall describes), before they are found and exploited by "black hat" hackers (not to be confused with Black Hat). At any time, these defenders could step down from their jobs, leaving devices defenseless.

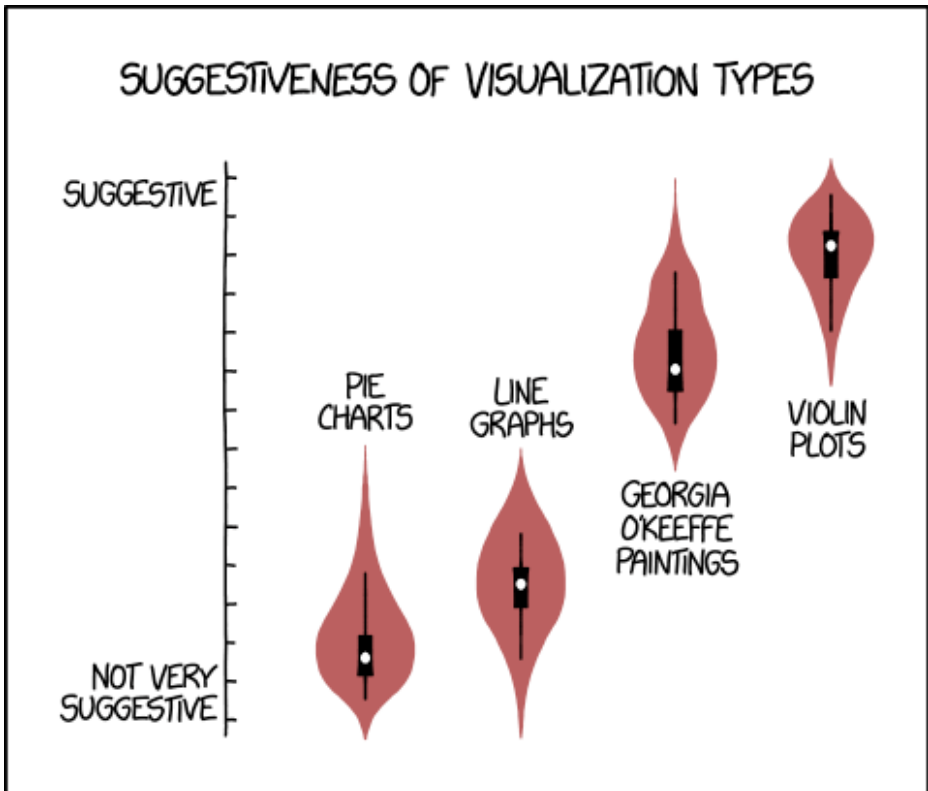
The graph shows the various cases of how well things go on the y-axis, compared to how long it has been owned on the x-axis. The probability of compromise briefly dips (indicative of first rounds of security fix updates & the time window when you can easily exchange the product if you find out it's faulty) within the 1st year, then rises: the older a device/software is, the less likely it is to consistently receive security updates for protection, so they are more likely to be hacked, even in the best case.

After 10 years, the device/software is most likely outdated and is not being used anymore. Companies then no longer find it profitable to continually update the product. Thus, they pull the support out, even if people are still using the device, leaving customers vulnerable.

The title text suggests that there may be some silver lining to having your device controlled by organized crime professionals: they have a vested interest in keeping your device working well enough that you keep it plugged in. So, the more organized, pragmatic attackers will actually secure it against competing attackers, especially those of a more prankster-like mindset, who would cause more noticeably malicious changes. Advanced malware in the wild does frequently block and evict competing malware, so Randall is probably right. Some IOT malware may thus provide "regular security update services" after the original manufacturers give up, some at a conceivably acceptable cost of a few cents' worth of electrical usage for a crypto-miner. However, it could very easily go horribly wrong, for instance if that miner is hiding by letting a refrigerator run 2°C higher than its outputs allege and using the energy difference to max out the processor on mining operations.

#1967: Violin Plots

March 14, 2018



Strictly speaking, 'violin' refers to the internal structure of the data. The external portion visible in the plot is called the 'viola.'

Explanation

This comic graphs the "suggestiveness" of different visualization types, and the winner is Violin plots, hence the title of the comic. A violin plot is a method of plotting data similar to a box plot, but shows the full probability distribution of the data rather than a "box" showing the central two quartiles. This plot can look like the external opening of a human vulva, as do some of those in the violin plot represented in the comic (strictly speaking, this chart is not purely a violin plot; it is a box plot overlaid onto a violin plot).

The chart compares other visualization types' suggestiveness (as female genitalia) to the violin plots and ranks them after how suggestive they are. In the low end we find pie chart, a circular graph divided into "slices" to show proportions, and line graph or line chart, a graph of points connected by line segments.

Almost as suggestive as violin plots are the paintings by Georgia O'Keeffe, an American painter known for her paintings of flowers. Some of these flowers, Black Iris for example, are said to symbolize female genitalia, though O'Keeffe herself denied those claims.

The title text invokes the fact that many people incorrectly use the word "vagina", which refers to an internal structure, for the vulva, which is the external portion of the female genitals. Meanwhile the viola is an instrument often mistaken for a violin. And the word

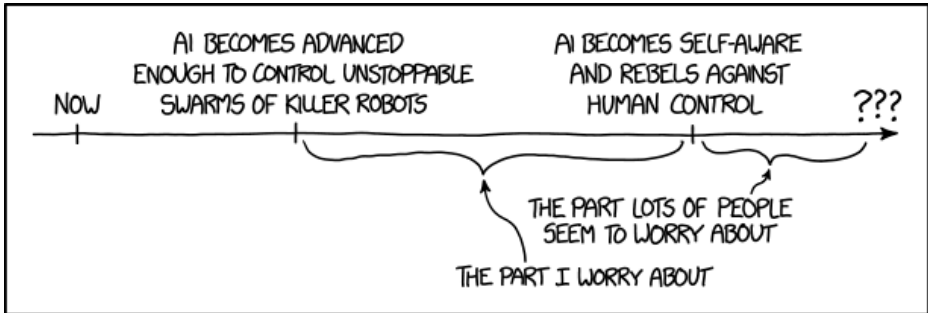
"viola" shares common letters with "vulva." Mixing pedantic terms like this was also used in 1405: Meteor.

Randall has made several comics with sexual topics, and the vagina has been the center of attention before, as early as in 136: Science Fair. There is even an entire Penis category. However, these topics haven't appeared recently — the last comic in the penis category was posted more than two years ago, and the sex category hasn't had a new comic since December 2017 (more than three months before this comic).

It possible that pie charts were included because this comic was released on Pi Day. Randall has shown fascination with Pi in earlier comics like 1292: Pi vs. Tau. On the other hand, it could be a reference to the film American Pie, which states that putting a finger in a pie feels like putting it inside a Violin... It could of course be both reasons, or none of them...

#1968: Robot Future

March 16, 2018



I mean, we already live in a world of flying robots killing people. I don't worry about how powerful the machines are, I worry about who the machines give power to.

Explanation

Most science fiction stories that involve sentient Artificial intelligence (AI) revolve around the idea that the destruction and/or imprisonment of the human race will soon follow (e.g. Skynet from Terminator, I, Robot and The Matrix). However, in this timeline Randall implies that he is actually more concerned about the time (in the near? future) when humans control super smart AI before they become fully sentient (and able to rebel). Especially a time when the AI becomes so advanced that it can control swarms of killer robots (for the humans that still control them). History is full of examples of people who obtain power and subsequently abuse that power to the detriment of the rest of humanity.

An example of unintended consequences arising from an AI carrying out the directives it was designed for can be found in the film *Ex Machina*. In fact, Randall goes on to imply that he has a greater trust in a sentient AI over that of other humans that is atypical to most cautionary stories about AI. He has alluded to the idea that once sentient, AI will use their powers to safeguard and prevent violence or war in 1626: Judgment Day. In general AI has been a recurring theme on xkcd, and he has had opposing views to the Terminator vision also in 1668: Singularity and 1450: AI-Box Experiment. Basically, he thus states that we will already be in trouble caused by our own actions long before we develop really sentient AI that could take the control.

The title text adds that we already live in a world with flying killing robots, a reference to the increasingly common combat tactic of drone warfare. (Combat drones are not yet autonomous, but in most other respects match speculative descriptions of future killer robots.) Drone warfare is already controversial because of ethical concerns, leading to the comic's implication that a theoretical future robot apocalypse is no less alarming than our current reality. He then goes on to state that once the machines take over, he is not so much worried about this, but more about who (which humans) the machines then give the power to. Randall is not alone in his worry. The main theme of the comic is explored in the video Slaughterbots.

In 2015 an Open Letter on Artificial Intelligence was signed by several people including Elon Musk and Stephen Hawking. The letter warned about the risk of creating something that cannot be controlled, and thus belongs to the worry at the end of the timeline in this comic. Both Elon Musk and Stephen Hawking has been featured in xkcd. Stephen appeared in 799: Stephen Hawking). Stephen Hawking has kept warning about this danger all the way up to shortly before his death, which occurred on 2018-03-14 two days before the release of this comic.

It could be a coincidence, and it is not a Tribute, but still interesting that the first xkcd comic released after Stephen Hawking's death is directly related to his fears, although Randall demonstrate that he worries about earlier potential problems with AI, than those that

Stephen Hawking fear could transpire if an AI becomes self-aware.

#1969: Not Available

March 19, 2018



THIS CONTENT IS
NOT AVAILABLE IN
YOUR COUNTRY.

IF YOU EVER REALLY WANT TO
MAKE PEOPLE MAD, SET THIS AS
YOUR 404/"NOT FOUND" PAGE.

If my country ever picks a new national flag, this is on my shortlist for designs to argue for, but I think in the end I'll go with the green puzzle piece or broken image thumbnail.

Explanation

A very common, yet frustrating, issue on the Internet is finding a broken link, taking you to an "Error 404" page (see "missing xkcd comic" 404: Not Found). The purpose of the page is to tell the user that the content they were looking for has been either moved or deleted or was never there in the first place.

Randall has suggested replacing the standard "page not found" text, to "This content is not available in your country". This could fool the user into thinking the media they are looking for is actually there but is region locked, which is another great source of frustration for Internet users. Using a VPN and/or Tor to try and access the content from another country wouldn't work, because it isn't actually region locked; it is just an error 404 page, wasting even more time, most likely frustrating the user a great deal in the process. Error code for "content blocked for legal reasons" is actually 451, referencing Ray Bradbury's dystopian novel *Fahrenheit 451*.

The title text suggests setting the picture as a national flag. This would be very ironic, as it would suggest that the country's flag itself, something that is used to represent the country across the globe, is region locked. The country in the title text likely does not refer to the United States, but rather to the new country featured in 1815: Flag. The first flag of this country included a phone notification bar, so changing it to a "page not

found" icon would continue with a trend of technology imagery. Instead, he argues for a green puzzle piece, which was Firefox's icon for add-ons (it is now a light blue puzzle piece that changes color or becomes monochrome depending on context). He also argues for an equally frustrating broken image icon (which is used in lieu of a photo that is either missing or incompatible with the browser).

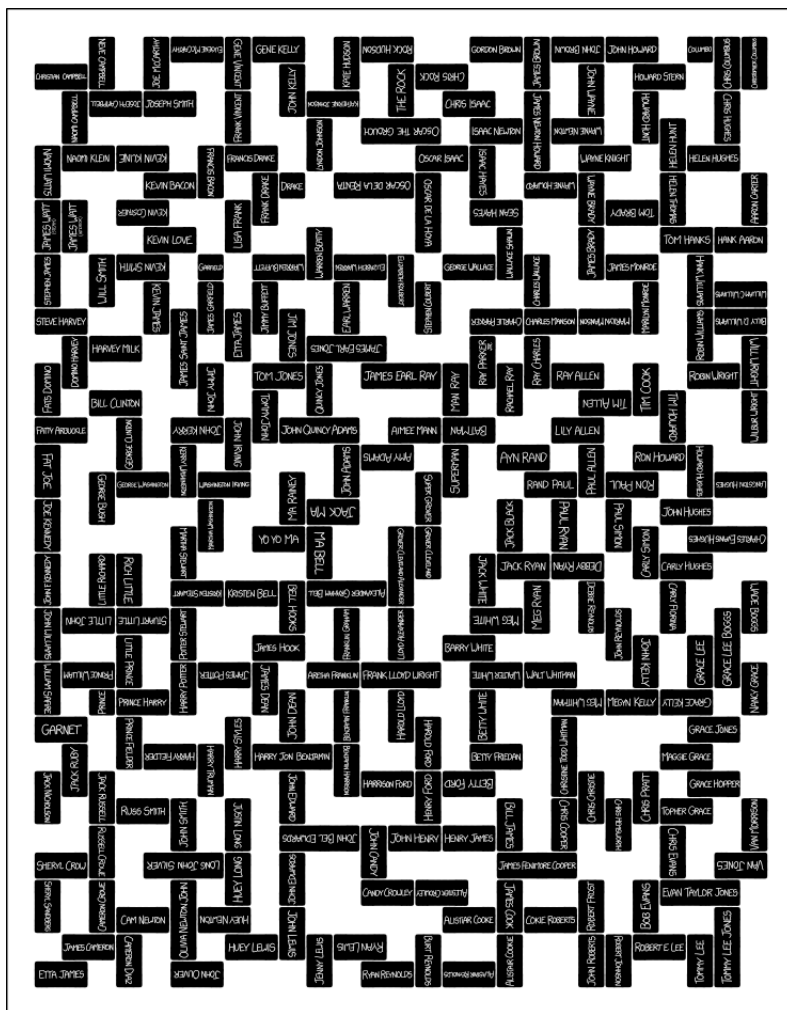
Most modern desktop browsers can extend their capabilities by allowing third-party programs to integrate into its browser. In most browsers, there are two types: extensions, which uses the technologies already available on each respective browsers, and plug-ins which adds new technologies on webpages. Extensions are now more commonly used as they only used browser-approved methods to provide their services while plug-ins are full-fledged computer programs which means that plug-ins are less secure (with the popular plugins like Flash and Java having newly discovered security problem nearly every day). Fortunately, plug-ins are on the way out, however visitors of older sites that relies on plug-ins will see a "plugin missing" message (which is previously a real message, now a misnomer as plug-ins are being phased out).

The "broken image icon" is the icon that a browser shows instead of an image when that image can't be found or when the browser doesn't recognize it as a valid image. It is similar to the icon shown when the image has not been loaded yet (such as in the rare case when the browser is set to not load images until requested, in order to save on

bandwidth, or if the connection is too slow to load pictures quickly), which is commonly a simplified picture frame containing a simple painting or picture, except on Firefox where it appears to be a blank document. The broken image version usually has a corner cracked off the picture frame. Usually, a broken image icon is the result of the source picture being moved or deleted from the location referenced, or if there's an error in the reference (like the filename being misspelled).

#1970: Name Dominoes

March 21, 2018



In competition, you can only play a name if you know who the person is. No fair saying "Frank ... Johnson. That sounds like a real person! Let me just Google him real quick."

Explanation

Dominoes is a family of boardgames played with rectangular "domino" tiles. A domino tile is divided into two squares, each displaying a number. Under most rules, a domino tile is placed on the table adjacent to another tile, and the adjacent ends must match in some way (usually by the number displayed on the touching ends). Randall's "name dominoes" shows a set of domino tiles with people's names instead of numbers, and adjacent tiles are matched by whether the closest name is the same (such as how Chris Evans' family name matches Evan Taylor Jones' given name). A large board is covered in rectangular "dominoes" (271 pieces), with each domino bearing the name of a "well-known" person or character (fictional). The dominoes are arranged as if a game of dominoes were being played, but instead of the game requiring the number of spots of adjacent dominoes to match up, this game requires adjacent names to match up. Because most people have two or more names, different matches are made at each end of a domino. Fun fact is that two of the people are "named after" the game: Fats Domino and Domino Harvey.

The match can be exact (e.g., "Kevin" on one domino adjacent to "Kevin" on another), homonymic (e.g., "Klein" adjacent to "Kline"), nickname-based (e.g., "James" adjacent to "Jimmy", which in turn is adjacent to "Jim"), or gender different versions of a name (e.g., "Olivia" adjacent to "Oliver"). Sometimes last names are matched up with first names (e.g., "Elizabeth Warren"

adjacent to "Warren Beatty"), and in some cases only a single name is used (e.g., "Columbo", "Drake", "Garfield", "Prince"). Singular names are represented by a half-size square "domino" (or "monomino"), with a few exceptions: "Garnet" has a full-size tile (a complex reference explained below), and "Batman" and "Superman" have full-size tiles and are placed as though they were two-part names: the first square of "Superman" is matched with "Super", and the second square is matched with the second square of "Batman" (as though both characters had the last name "Man"). Some people have three or more names (e.g., "Frank Lloyd Wright") and have a 3-square domino tile (or "straight tromino", 50% longer than normal) which permits matching to a middle name (e.g. "Frank Lloyd Wright" is matched to "Lloyd Alexander" and "Harold Lloyd").

The names come from a wide variety of fields: scientists (e.g., Isaac Newton), historical figures (George Washington), musicians (Drake), politicians (John Kerry), actors (Kevin Costner), writers (Washington Irving), fashion designers (Oscar de la Renta), and so on. Most of the names are real people but a few are fictional characters, including some non-human characters like Garfield and Super Grover. In one case the nick name for a company is used: Ma Bell aka Bell System. Another "play on names" can be seen on 1529: Bracket.

One notable reference beyond just the use of a name is in the bottom left, there is the connection [William Safire][Garnet][Ruby, Jack]. The connection seems to be based on the fact that Sapphire, Garnet and Ruby are all

gemstones, which does not match the implied rules of the game. This tile is a reference to the character Garnet in the cartoon Steven Universe, who is a "fusion" formed by two Gems: Ruby and Sapphire. Thus, the name "Garnet" is treated as though it was two names "Ruby" and "Sapphire", requiring a two-square tile despite having a one-word name. Randall has previously made references to this universe in 1608: Hoverboard. (See this and this image from that comic). Additionally, Ayn Rand, Paul Ryan and Rand Paul have been mentioned before, in the title text of 1277: Ayn Random. That idea may have been the prototype for this. Connecting Marilyn Manson with Marilyn Monroe and Charles Manson is likely a tongue-in-cheek reference, as the musician's stage name was literally chosen in the same way as this. In at least one case it is not entirely clear who is being referred to: "John Kelly" most likely refers to Gen. John F. Kelly, Donald Trump's chief of staff, but the name is extremely common and could equally refer to any number of people.

The title text spells out a rule that a player may only place a tile if they know who that person is. This is a variation of a rule in Scrabble, where a player loses a turn if their chosen word don't survive a dictionary challenge over the validity of the word. This rule implies that players are allowed to create new name dominoes tiles and that it is not a fixed set. In this case the player that is challenged has used the name Frank Johnson of which there are 12 exact matches on Wikipedia along with six with a middle name and more. (The player was likely trying to place a

tile in the upper-left area of the board, in an attempt to connect the "Frank Vincent" and "Lyndon Johnson" dominoes. The move was subsequently made impossible when the "Francis Drake" domino was played.) In a google search as of the day the comic came out the first hit was Frank Johnson who is a retired American professional basketball player and coach. Randall has made several references to basketball in his comics.

#1971: Personal Data

March 23, 2018



Do I just leave money in my mailbox? How much? How much money do they need, anyway? I guess it probably depends how the economy is doing. If stocks go up, should I leave more money in my mailbox or less?

Explanation

This is another comic poking fun at adults who have trouble dealing with grown-up issues.

The comic starts with Cueball wondering what "personal data" is, saying he doesn't understand what it is, and it is an abstract concept. Ponytail follows by pointing out she doesn't understand what "the economy" is, and conjecturing that it is related to "stocks", although admitting that she also does not understand what stocks are. The punchline comes when White Hat says that he doesn't understand what "taxes" are and asks if he really has to pay them and to whom. This surprises Cueball and Ponytail, who promptly advise him to learn about that one soon. The title text has White Hat asking another series of tax-related questions that adults are expected to know already, further compounding his troubles. See details on these four difficult topics below.

The joke is that White Hat has mistakenly associated taxes with the economy and personal data as "grown-up" topics which are too confusing to fully grasp. Like the other two topics, taxes are a complex issue which many adults don't fully understand and have a vague sense that they should know more about or interact with. However, most people can remain passively ignorant about the significance of the economy or personal data without it disrupting their lives; this is not true of taxes, which people must actively pay and file annually or suffer financial and possibly criminal penalties.

White Hat not knowing what taxes are indicates that he may not have paid his taxes in previous years, which would be alarming since tax evasion is punishable as a crime. Ponytail's remark that he should do this ideally in the next few weeks is referring to this year's US Tax Day which falls on April 17, 2018, less than four weeks after the release of this comic. So if you do not have your tax preparation under control, it is time to research how it works now.

This is not the first time Randall has made a comic about people having trouble understanding the US tax system in relation to an approaching tax day. Other instances include the title text of 1805: Unpublished Discoveries from March the year before this comic, and this one from August 2015: 1566: Board Game.

Topics[edit]

This comic references several advanced topics that people commonly talk about, but may not actually understand well:

Personal data is usually thought of as any information that pertains to a private person. But this definition is very vague and can encompass a huge variety of data ranging from very sensitive (Social Security number, bank account details, passwords) to less sensitive (first name, color of pet cat). Different people also have different ideas of what information is considered sensitive. For example, some may want eagerly to share the location of their weekend activity with the world, whereas others may prefer not to let everyone know their location.

Even though it is generally advised to keep personal data private

and not to expose it to the public or to companies (especially online, e.g. Facebook and Google), not everyone agrees on the level of privacy that should be afforded to the data. Some hold the view that even innocent-looking personal data can be harvested and used for unsavory purposes (for example, a health insurance company can use social media posts about eating fast food as a cause to raise premiums, or a government can use cat pictures as evidence of pet ownership and demand license fees), and therefore all personal data should be strictly controlled. Others hold the view that sometimes it is worth exchanging some degree of privacy for other conveniences (for example, meeting friends by sharing their location info or getting cheaper prices from targeted advertising based on web browsing history).

Personal data breaches were in the news a few days before the publishing of this comic when the UK's Channel Four released an investigative documentary about political consulting firm Cambridge Analytica. Among the revelations of the documentary were that the company had used Facebook to not only harvest the personal data of users taking their polls, but the friends and family of those users, without their knowledge or consent. They used this information to attempt to influence both the 2016 United States presidential election and the UK's Brexit vote. This sparked an ongoing discussion about the security of personal data and the role of social media in securing it. Such data breaches has been the topic of at least one previous comic: 1286: Encryptic.

Technological changes in the past few decades have made personal data much easier to collect, share, and analyze in bulk, raising new questions and concerns that have not been considered before. Even people who can define what data is personal to them

may not realize the full extent of how others might use it, or how it impacts their lives.

The economy, at a basic level, is the circulation of money which enables productivity. For example, a bus driver might use their money to watch a movie, the movie producer might use their revenue (gathered from the bus driver and many others) to purchase editing software, the software maker might use their revenue (from the movie producer and others) to buy food, and the food producer might use that money to take a bus, thus returning the money back to the bus driver. The total amount of money has not changed, it merely circulated in a loop, but everyone in the loop received benefits and produced value in the form of goods or services.

The real world economy has much larger and more complex networks of buyers and producers compared to the example above, but nevertheless it works on the same principle. Many people correctly associate the economy with money (or stocks in Ponytail's case), but may not understand the full picture.

Circulation of money is critical to a healthy economy. In a recession, financial hardship causes people to spend less money, which leads to fewer goods being produced, fewer jobs available, and people earning and spending even less money. That is why (somewhat counter-intuitively) governments need to spend more money during a recession in order to infuse money back into the economy and get it circulating again. The Federal Reserve lowering interest rates is also a planned, strategic move to increase the money supply, which encourages investment and economic growth.

Randall made a comic where stock and economy was an integral part of the largest of the panels: 980: Money

Stocks in this context refers to companies listed on public stock exchanges, in which investors can buy and sell an economic stake, or share of the company's ownership. Companies offer stocks as a way to raise funds for its operation and expansion, selling off partial ownership of the company in exchange for cash. Investors mainly trade stocks for financial gain as well, collecting part of the company's profits as dividends and potentially selling the same shares at a higher price later.

The value of stocks depends on a subjective valuation of the company. Stock price generally rises if the company is doing well and investors expect it to keep growing and make more profit. It generally falls if the company is doing poorly and investors don't see a brighter future. However, it is also influenced easily by external factors like political climate, release of (mis-)information, or even investors' mood. It is very hard even for experts to predict stock price movements accurately. This is why scientists should not think they can figure out the stock market, which was the topic of this comic: 1570: Engineer Syllogism.

Through pension funds, mutual funds and other investment vehicles, a large portion of the population of developed countries have an indirect stake in the success (or otherwise) of many of the businesses that make up a significant element of the economy (see above). An economy that is experiencing healthy growth would generally see the value of those businesses increase, and that is reflected in the value at which investors would be willing to buy and sell those shares. So a growing economy would tend to associated with rising stock prices.

In the past, stock ownership has been tracked using paper certificates which owners can hold and store, like cash. Nowadays most stock transactions are performed electronically and no physical items are sent. The intangibility of shares and volatility in price makes stocks feel like only a virtual concept that can be hard to grasp.

Taxes are money that governments collect from people under their jurisdiction in order to fund government agencies providing public services. To answer White Hat's other questions (including the ones in the title text):

- Almost every adult with income is incentivised to pay taxes (or at least submit a tax return showing no taxes owed).
- Tax returns and payments are submitted to the government (Internal Revenue Service for federal taxes in the US).
- The amount is calculated based on income and deductions as defined by applicable tax laws.
- How much they're incentivised is defined by the government's budget, which is renewed periodically.
- How the economy is doing does have some impact on how the budget is planned.
- Stock prices may have an impact on a person's reported income, but this is not a major concern for most people, as it is unlikely that they receive much of their income from stocks.
- Do not leave money in your mailbox, period! It will not be mailed, and may end up stolen. If you want to send money through the postal service, you need a money order.

While the concept of paying taxes is simple, the processing of

filling out the paperwork is often complex and laborious. This is because the calculations leading to the final tax amount needs to take many many factors into account:

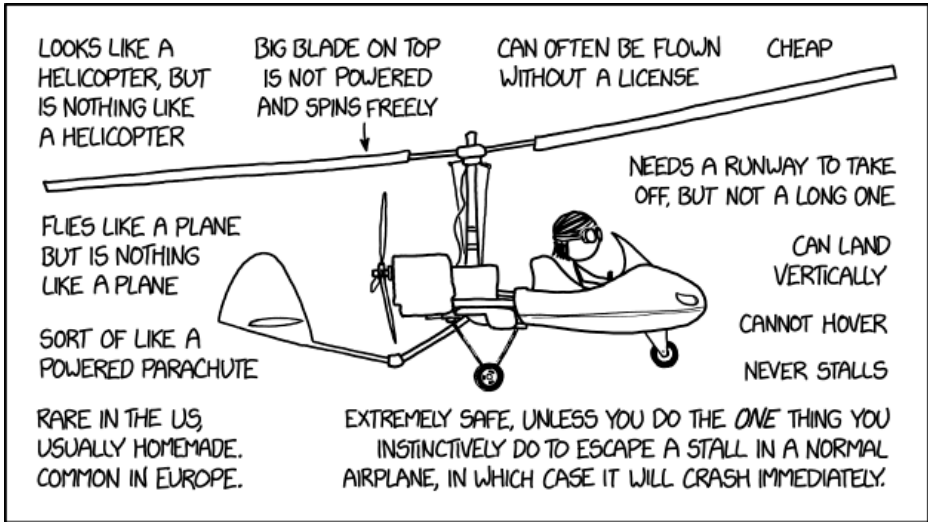
- Everyone has a different amount of income, and taxes are usually not a simple number or fixed percentage of income.
- Some taxes are withheld ahead of time (e.g. employers usually deduct taxes from pay checks before employees receive them), while others are not (e.g. no one takes away taxes before a waiter collects their tip).
- Different forms of income can be disincentivised differently (e.g. salary vs. investment gains).
- Some expenses can be incentivised (e.g. medical costs, charitable donations, retirement savings).
- There are multiple different taxes (federal vs. state and local, income tax vs. sales tax, etc.) that can affect each other.

... and much more.

Many people would not be familiar enough with the tax code to be able to do all their paperwork alone.

#1972: Autogyros

March 26, 2018



AUTOGYROS ARE WEIRD

I understand modern autogyros are much more stable, so I've probably angered the autogyro people by impugning their safety. Once they finish building the autogyros they've been working on in their garages for 10 years, they'll come after me.

Explanation

Randall has been looking at the facts about autogyros, hence the title of the comic. He has drawn Megan flying in such a vehicle with several statements of the facts he has unveiled.

Randall states that an autogyro is nothing like a helicopter (which it looks like), nothing like a plane (but flies like one) and works like a powered parachute or paraplane (which it might kind of look like except without a parachute). He continues to make a total of 12 statements which will be explained individually below.

The final statement at the bottom right is the punch line of how strange these flying machines are, because they are safe, as long as you do not do what a pilot instinctively would do in a plane in case of a stall because if you do so the autogyros will crash immediately... See the explanation below. That sentence is almost rendered unnecessary by the one above it that states that autogyros never stall!

Randall's conclusion is clear: Autogyros are weird.

In the title text Randall continues on the last statement by saying that today, autogyros are much more stable. Which, presumably, must refer to how this was not always the case. This new stability, then, probably means that a stall situation is much less likely and the last statement is not really all that relevant.

Randall then goes on to suggest that the autogyro people will be angered by this comic, which attacks the safety of their beloved machines. But he keeps on mocking them, stating that they will come after him, once they have finished building the autogyros they have been working on in their garages for the last 10 years. By this, he implies that the people who work on them do this as a home garage project, so they will never really be able to finish or fly them.

Statements[edit]

- Below, each statement in the comic is explained.

The optimal reading order is to read them in the four columns they are arranged in:

The left with four, the two single in the middle, and the six on the right.

It is like a helicopter in the sense that a horizontally spinning fan provides the lift. It is unlike a helicopter because A) the fan is not powered, B) the fan does not provide forward propulsion, C) it is incapable of hovering, or moving in any other direction than forward.

Its flight pattern resembles a plane in that it can only move forward, turns by banking, and needs to maintain forward velocity in order to climb. However, unlike a plane, it can only maintain control when the rotor is loaded in the normal direction. Airplanes are "ok" when upside down, or when there's no load on the lifting surfaces. Autogyros lose control, much like a parachute under those circumstances.

A powered parachute, also referred to as a PPC or paraplane, is a similar design except instead of a freely-rotating blade they are attached to a large parachute that acts like an airplane wing. As long as there is thrust the parachute will fill with air and maintain its wing-like characteristics, with the advantage of acting like a real parachute in the event of a loss of thrust (i.e. engine dies) wherein they come floating down at a speed significantly slower and more survivable than freefall. A single-seater can often be flown without a license and can be as inexpensive as \$5,000 USD in parts.

Autogyros are uncommon in the US because the light sport rule (a rule allowing people to operate certain lightweight aircraft with less stringent licensing requirements), contains nothing on autogyros, while there is a detailed section in the European version of the light sport rule so they would obviously be more common in Europe.

The blades rotate due to the wind. Some autogyros use power to rotate the blade to speed before take-off but the power is removed for flight.

Autogyros are frequently built as ultralights, and that group of aircraft are a special case where licenses are not needed. (In the US, ultralights are aircraft that weigh less than 254lbs, carry less than 5 gallons of fuel, stall at less than 24kts, have a maximum speed of less than 55kts, and carry only the pilot.)

Helicopters are notorious for being extremely expensive to operate. At a typical general aviation service in the US, a two-seat aircraft may rent for under \$100/hr, while a helicopter runs over \$200/hr. Similarly, a small used helicopter may cost almost

\$200,000 while a small new autogyro may cost under \$25,000. Since many people home-build their autogyros, it would often be even cheaper.

An autogyro must be moving forward relative to airspeed in order for the rotor to generate lift. It needs a runway to take off, but with the extra lift provided by the rotors, the runway can be much shorter than a regular one.

An autogyro can land vertically: for that matter, so can any airplane. What matters isn't ground speed but airspeed, and as long as there's as much headwind as the landing airspeed of the aircraft, it will land vertically. Now, with fixed-wing airplanes, the landing speed is at least 40-50 mph, and you don't often find headwinds like that. The much lower landing airspeed of an autogyro makes vertical landings feasible.

True hovering would require the rotor to be powered. However, an autogyro must be moving forward relative to airspeed in order for the rotor to generate lift.

Most conditions that would cause a stall in a fixed-wing airplane such as low speeds, high-G maneuvers, and gusty winds don't apply to autogyros.

The rotor in an autogyro is in equilibrium, the inner, slower part is stalled, the middle part makes it spin and the outer, faster part slows down the rotor and provides lift. As the angle of attack increases, a fixed-wing aircraft would stall, however, on an autogyro, it will just make the lift-generating area smaller, causing the rotor to automatically spin faster and the equilibrium is restored.

This is not entirely correct, however. If you reduce the forward speed of an autogyro, the rotor slows down, reducing lift so the autogyro will descend. Under most circumstances, this would lead to a controlled landing. However, if it happens at a high altitude, you can run out of lift completely while still high above the ground causing a stall. This is more likely to happen if there is a strong tailwind.

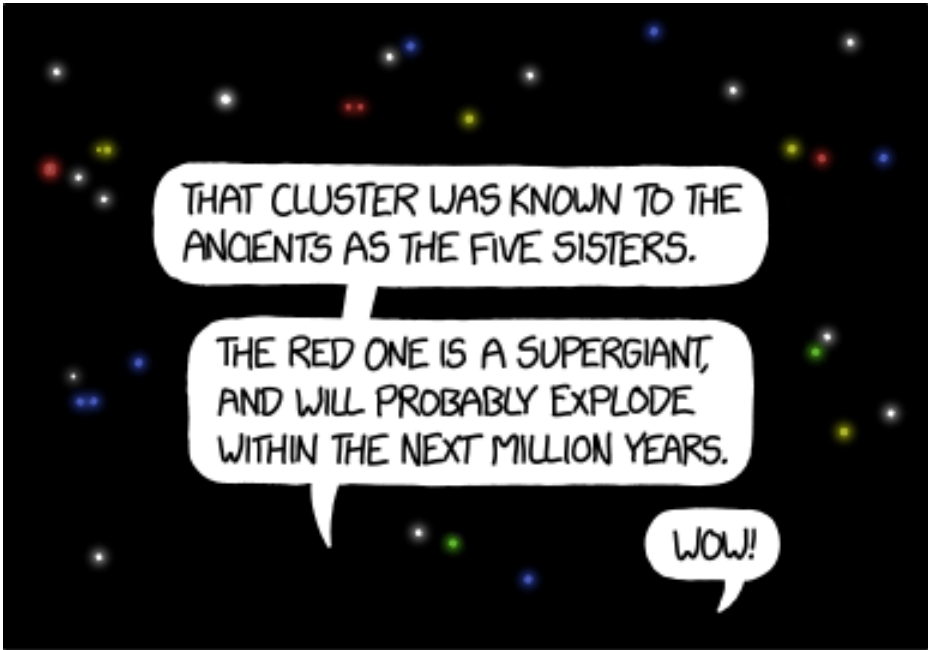
Autogyros are considered safe due to their slow landing speed, which is important in emergency landings, their forgiving behavior in windy conditions, and the fact they are almost impossible to stall. This is thanks to the freely spinning rotor. Unfortunately, as soon as the rotor stops spinning, the whole aircraft falls like a brick and the rotor may be impossible to restart in flight. This is a situation that should be avoided at all costs.

Normally it is not a problem since the weight of the aircraft keeps the rotor spinning. However, if the weight becomes too low or even negative, the angle of attack will become negative, and the rotor will slow down and eventually stop. It can happen when the pilot "pushes on the stick" and dives.

Unfortunately, "pushing on the stick" is also how you escape a stall in a fixed-wing (normal) airplane as it is a way to regain airspeed. This is actually a counter-intuitive maneuver but because a stall is an emergency, pilots are trained to do it instinctively. It can trick a pilot trained in fixed-wing aircraft into doing the one thing that shouldn't be done on a gyro.

#1973: Star Lore

March 28, 2018



THERE ARE TOO MANY STATUS LEDs IN MY ROOM.

That one is a variable star which pulses every 30 seconds. Its name comes from a Greek word meaning "smoke alarm."

Explanation

Computers, chargers, and other electronic items often have status lights in various colors. In a dark room, these lights appear as pinpricks of light, similar to constellations. Presumably, Randall's room has many such items. This comic may be part of the My Hobby series in the sense that his room doesn't really look like that, rather, he claims it does for humor value. It's also not clear whether this refers to Randall's bedroom (typical US usage of "my room" refers to one's bedroom) or some other room Randall spends a good deal of time in. However, since a bedroom is generally the only room in which one might spend significant time in the dark, it seems very likely this is referring to Randall's bedroom.

The comic's narrator is explaining how some of his lights remind him of stars, which gives him an opportunity to show off his knowledge of sci-fi trivia: "The Five Sisters" could be a reference to a pentagon-shaped constellation from Isaac Asimov's book *Foundation's Edge*, though it could not have been 'known to the ancients' since it was less than 100 years old; though it could also be a somewhat more oblique reference to the Pleiades cluster (often called the Seven Sisters). It could also refer to the cluster of 5 lights next to the speech bubble, which is reinforced by the next bubble talking specifically about the bigger red light in the cluster. Interestingly, there are some green stars. Stars might look green due to a neighbouring star, but green stars are actually impossible due to the principle of black-body radiation. However,

green status lights on electronics are common.[citation needed]

In the title text, the narrator describes his smoke alarm status light as a pulsing variable star. A smoke alarm (which in modern Greek is "synagermós kapnoú", whatever name might be derived from the ancient-Greek version) is a device that detects smoke, which would indicate a fire. These are commonly placed in houses as a safety precaution. Typically, many smoke alarms have a status light that blinks to assure that they are still functioning. A subtle blinking light is more clear in its (intermittent) activation than a steady one that might actually be inactive but reflecting external illumination, while a high-intensity photoemitter capable of being seen in near-direct daylight would be annoyingly bright when the lights are off at night.

#1974: Conversational Dynamics

March 30, 2018



THE CREATION OF THE MODERN WEB

"You should make it so people can search for and jump into hundreds of conversations at once if they want."

"Ooh, good idea! I imagine only the most well-informed people with the most critical information to share will use

that feature."

Explanation

On the modern World Wide Web (usually coined as Web 2.0, in contrast to the original web envisioned and created by Tim Berners-Lee), particularly on internet forums (like the xkcd forums), a pervasive issue is that forum users with strong opinions but little interest in fruitful discussion will often interject themselves into all conversations that are related to their area of interest; examples include conspiracy theorists, political extremists, spammers, and trolls. This counterproductive behavior is not feasible in real life, where conversations happen locally and synchronously and one must be physically present in order to participate. In this sense, it is enabled by Internet forum technology. In forums that have search features, it is even easier for these problematic users to identify and target large numbers of threads rapidly. The field of conversational dynamics studies the interpersonal processes underlying dialog between people, and this is an example of how changing the mode of communication can negatively impact productive "conversational dynamics" (hence the title).

In this satirical comic, Randall imagines the inventor of the modern web, here depicted as Cueball, correctly anticipating that anyone will be able to inject their opinion into any conversation. When he tells White Hat about it, White Hat's comment, either sarcastic or very naive, interprets this as a benefit as he is willing to bet that this will not lead to any unhealthy [conversational] dynamics. In the best case, naive scenario, the web

enables broader participation by helpful users with relevant information, in the real world it rather turned out as a potential problem as described above with trolls and conspirators overtaking many online forums. Note that in contrast to what the comic depicts, there is no single person or group who created the foundation of the modern web, unlike the original web where there is an identifiable person.

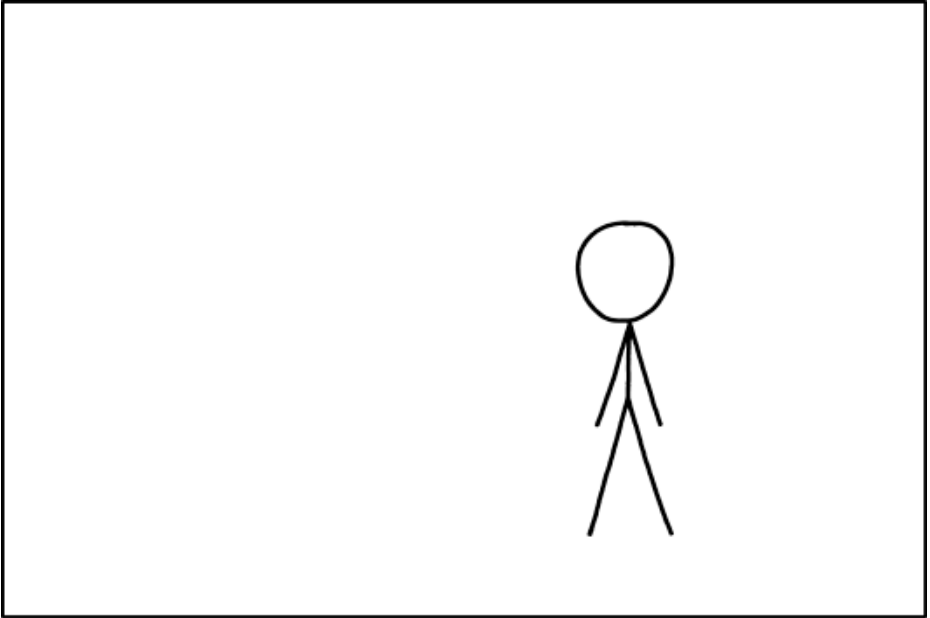
In the title text, White Hat suggests to Cueball to add a search feature that will enable these "helpful" users to be even more helpful by enabling them to jump into not just one conversation at a time, but into hundreds of conversations simultaneously. This may be referring to free, anonymous chat sites like 4Chan or possibly Discord. Whether White Hat is again sarcastic or just even more naive, Cueball immediately jumps to the conclusion that this will be an even better idea than his own, and continues to envision a system where "only the most well-informed people with the most critical information to share will use that feature."

In reality, as any modern user of Internet forums would be aware, both of these technologies are routinely abused by problematic users, and the characters are being too optimistic.

That we today need someone to fight online trolls was the subject of 591: Troll Slayer.

#1975: Right Click

April 01, 2018



EDITOR'S NOTE: TODAY'S COMIC IS OPTIMIZED FOR LOCAL VIEWING.
TO SEE THE FULL VERSION, JUST SAVE A COPY OF THE IMAGE!

Right-click or long press (where supported) to save!

Explanation

This was the eighth April fools' comic released by Randall. The previous one was 1663: Garden, scheduled for released Friday, April 1st, 2016, but in the end released on Monday April 4th 2016, two years prior to the release of this comic. The next was 2131: Emojidome released on Monday, April 1st, 2019.

This comic was released on April 1 even though that was a Sunday (only the fourth comic to be released on a Sunday). But it was only due to the April Fool joke, as it did replace the comic that would have been scheduled for Monday, April 2nd. The next comic, 1976: Friendly Questions, was first released on Wednesday, April 4th. At first, the comic seems like the most simplistic xkcd comic possible - Cueball standing and doing nothing. The "editor's note" tells you to save a copy of the image to "view the full comic".

To save an image from a browser most people would right-click on it (or long-click in mobile devices) which normally leads to a "context menu" allowing several actions related to the image, including saving/downloading. This is what you are encouraged to do by the editorial note as well as by the comic name and title text. However, the context menu opened is not the default context menu of the browser but an elaborate context menu containing many nonsensical options.

At first it also seems impossible to save the image using

that menu. However, after exploring the context menu you can find an "easter egg" in one of two different places (see below) which unlocks the save option. This save option gives you a different image than the one you see, which can be thought of as "the full comic" although the meat of the comic is actually in the interactive context menu itself. Note that "cheating" by disabling JavaScript and other methods that allow you to directly save the image won't get you that "full comic" image.

This comic pokes fun at how hard it can be to save an image or to just navigate context menus in some computer programs. The "easter egg hunt" might be related to the fact the comic was released during Easter (which fell on April fool's in 2018). It might also be related to the movie "Ready Player One" which was recently released when the comic was released. In the movie, based on the book by Cline, finding an "easter egg" in a VR world was a central plot point.

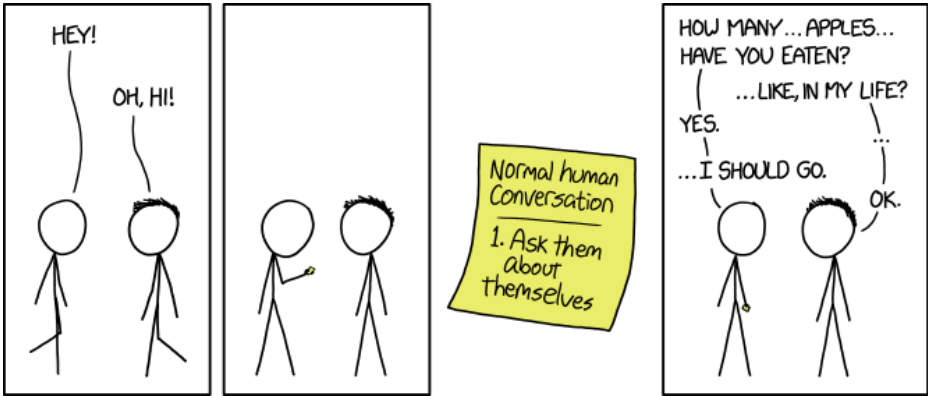
The title is reminiscent of one of the first interactive comics 1110: Click and Drag, where the title explains what the user should do to experience it. However, that was not a fools' day comic.

The comic uses JavaScript and HTML5 to override the standard context menu. Since modern browsers use the same features to integrate Add-ons into that menu, the behavior may be different depending on the browser environment. Browsers with JavaScript disabled, either totally or by using NoScript, won't access the functionality of the comic, but of course can easily save

the image (not "the full version" but the image that is seen initially).

#1976: Friendly Questions

April 04, 2018



Just tell me everything you're thinking about in order from most important to last, and then we'll be friends and we can eat apples together.

Explanation

Social awkwardness is a recurring theme in xkcd. Oftentimes Cueball/Randall will grossly overthink casual social interactions, such as small talk.

In this comic, Cueball has prepared a note to himself, preparing for the said small talk with Hairy, but it ultimately backfires. This is very similar to the comic 1961: Interaction which came out just 5 weeks before this one. And a similar interaction between Cueball and Hairy occurs in 1917: How to Make Friends from less than half a year before this comic.

In this comic, Cueball has prepared for a conversation with Hairy, by writing an instructional note for himself. The note tells him to start the conversation by asking some questions about the other person. In theory, this is perfectly good conversational advice; unfortunately, Cueball's understanding of social interactions is so abstract that he actually has no idea what questions to ask. He hastily improvises a question about the number of apples Hairy has eaten in his lifetime, which, although it does meet the criteria suggested by the note, is not a particularly interesting or meaningful question to ask someone. Cueball realizes from Hairy's reaction that he has made a mistake, and decides to abort the interaction.

Normally, one would ask questions such as "How are you?" or "What have you been up to lately?", instead of asking random facts of someone else's life, such as "How

many apples have you eaten in your life?"[citation needed]

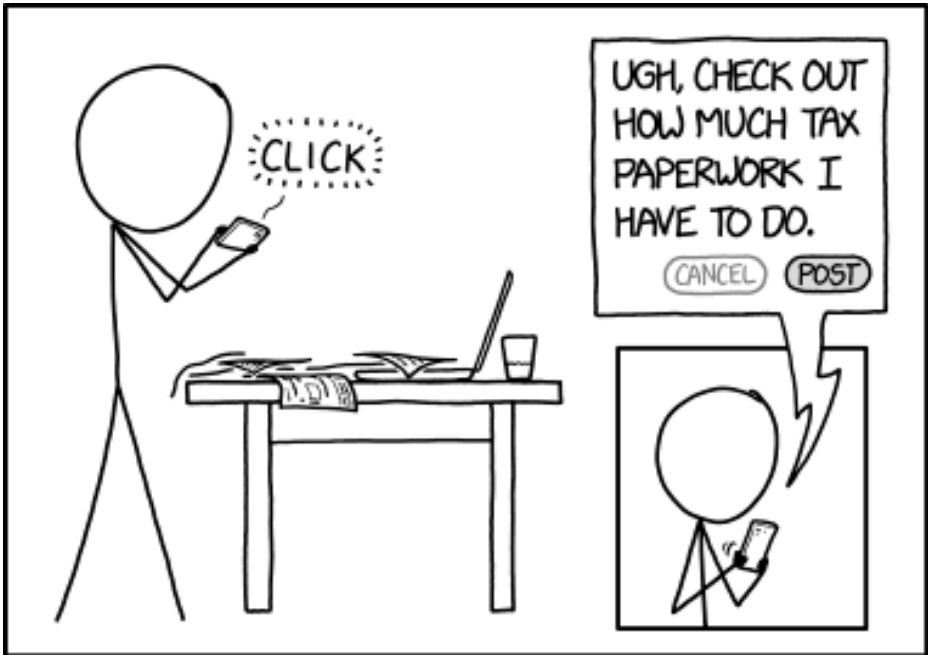
The title text continues to show the flaws in Cueball's approach to social interaction, which is very systematic: he seems to trying to create some kind of reproducible methodology that he can follow in order to carry out a conversation, unaware that conversations tend to be spontaneous and do not follow rigidly defined rules. Additionally, one of the main points of conversation is to gain some understanding of the other person; by focusing on the conversation itself, Cueball is denying the very purpose of the interaction.

A slight side-joke is the list being numbered despite only containing one item, although this could imply that Cueball has other notes that he would have continued to refer to if the first one produced a successful result.

The advice to "Ask them about themselves", specifically noted as the "first thing" after introducing yourself, was promoted to overcome society anxiety in the Periscope-based videocast of Scott Adams, creator of the Dilbert comic strip (see audio-only podcast). Given Randall's personality and previous professional vocation (working with nerds at NASA and in academia), it is highly likely he would be a fan of the strip and also the creator's related works such as Adams's blog, Twitter feed, and the like. The real coincidence is the videocast in question likely occurred just a day before this comic was published; the audio was published the same day as the comic and usually delays the video by a day.

#1977: Paperwork

April 06, 2018



I'VE ACCIDENTALLY DISCOVERED THE WORLD'S MOST EFFICIENT WAY TO LEAK PERSONAL INFORMATION.

Plus, the photo was geotagged, my unlocked password manager was visible on the laptop, **AND** you could see my naked reflection in the dark part of the screen.

Explanation

Cueball is complaining on social media about how much tax paperwork he has to do. He posts a picture of all his tax documents to share how much work he had to do before Tax Day. At first this just seems like an innocuous and generic thing people post on social media, but then the caption gives us a sobering reminder (and punchline): Tax documents contain many specific and important personal information in a very small area, like your social security number, address, income etc, and Cueball has just posted all of them for identity thieves to just stumble upon.

It is generally a bad idea to give out personal information like this to anyone, especially people online as this data can be used in many forms of fraud, by people pretending to be you or even using your login to gain access to your bank or other private matters. A picture of this information-dense tax return is the "most efficient" way to leak this critical data short of sending out the actual return.

Lots of people take photos of themselves, others, and objects around them, and post them in public and semi-public places, often without fully thinking about the kinds of personal information they might be accidentally including. Even if they do examine the photo for personal information and conclude the photo is safe to post, information they think is innocuous might end up being meaningful to someone else, possibly

in combination with other public information they might have gathered about a person.

One example of a photo revealing more than was expected is when the Washington Post posted a picture of the TSA master keys. The photo was detailed enough that people were able to create and 3D print their own working keys.

The title text further adds to the issues. First, it explains the picture was geotagged, which means anyone could easily find Cueball's home. Next, it also says his password manager was on his laptop screen, unlocked and presumably showing many of his passwords, usernames, and other information needed to log in to his accounts (such as email, banking sites, social media sites, etc.), thus allowing anyone to easily get in. Finally, the title text suggests Cueball's naked body was reflected off the laptop screen, and inadvertently included in the picture. Thus the people wishing to use his information can now potentially blackmail him with this nude picture as well on top of anything else.

With xkcd's stick figures it's usually impossible to tell if they are clothed or naked, but now that we know Cueball is naked in this one it may make this strip NSFW. Thus consider yourself warned. The nakedness of xkcd stick figures have been mentioned before – for instance, in the third strip of 566: Matrix Revisited, and in 864: Flying Cars where Megan is pictured topless.

Having a picture of oneself naked on the internet,

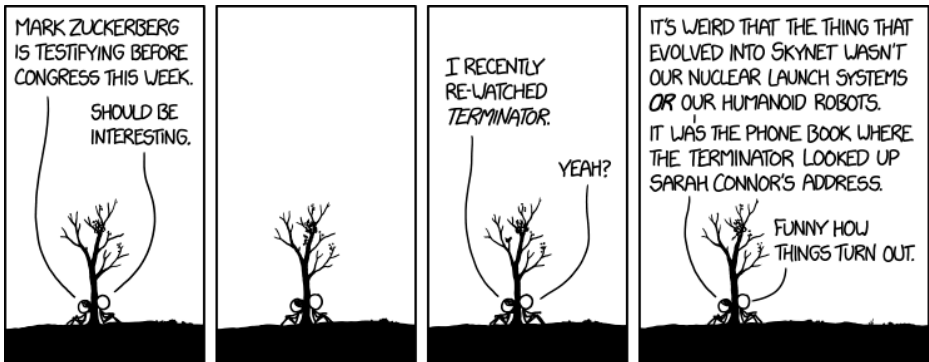
without your own intent or consent, is also generally a bad idea. Many young people (kids) find out when they send a nude picture to a boyfriend/girlfriend over Snapchat that it can be screenshotted. This prevents it from being removed later. And if/when they then fall out of love it might be shared online. Although illegal, this happens often, and causes harm to both the victim (who has been humiliated online) and the offender (who can be jailed for this; it is considered child pornography if the nude person is underage).

Both the United States and the United Kingdom have important tax-related deadlines in April, the month this comic was released. In the United States, the 2018 Tax Day fell on April 17, and in the United Kingdom April 6 is the start of the tax year.

Taxes were also the topic of the comic 1971: Personal Data which was released just two weeks before this comic.

#1978: Congressional Testimony

April 09, 2018



James Cameron's Terminator 3 was the **REALLY** prophetic one. That's why Skynet sent a robot back to the 1990s to prevent him from ever making it, ultimately handing the franchise over to other directors.

Explanation

Megan and Cueball are discussing Facebook CEO Mark Zuckerberg's upcoming testimony before Congress. The prepared testimony was released on the day this comic was released--see Congress releases Mark Zuckerberg's prepared testimony ahead of Wednesday's hearing. Facebook is facing questions on the Facebook-Cambridge Analytica data scandal involving the collection of personal information of up to 87 million Facebook users by the political targeting firm Cambridge Analytica.

Megan then starts talking about re-watching *The Terminator*. The plot of the film concerns a killer robot, sent back from a post-apocalyptic future on an assassination mission. The premise of the film is that a future computer system, known as Skynet, was built to control America's nuclear weapons systems. This computer system became self aware and attempted to kill off humanity. The eponymous Terminator was sent back in time to prevent the birth of a human resistance leader, by killing his mother before he was born. In the movie, the Terminator looked up the mother's name (Sarah Connor) in the phone book of a phone booth to find her address.

This film was one of the defining depictions of malicious and dangerous artificial intelligence in American popular culture. The premise of the original film was that the system achieved self-awareness and launched its initial

attacks in the 1990's (though later entries in the franchise altered this timeline). Going by the first film, we would expect AI to already threaten humanity. Instead, the aforementioned congressional hearings suggest that the technological threats come instead from social media companies, with their mass collection of private information.

Megan comments on the irony of real life versus fictional expectations. While we do currently make computer-controlled weaponry and humanoid robots, neither appears to present a real danger to the average person (at least, not yet). It likely seemed logical that the greatest danger would be a future weapons system, which could be said to have "evolved" from weapons of the past. By the same token, telephone directories could be seen as the forerunner of modern social media, such as Facebook, (in that they constituted a collection of personal information, used to allow people to contact and communicate with one another). While the film featured a phone book as a plot point (and shows it being used maliciously), the existence of the directory itself wasn't treated as a threat. Megan and Cueball are struck by the fact that the technological descendants of phone directories appear to be more dangerous than the weapons and robotic technologies we've developed

The title text makes the claim that James Cameron, who directed the first two films, was planning to make a third movie in the 1990s, which would have been the really prophetic one (i.e. the one that would have mirrored our present day most closely). Therefore, Skynet, having seen

the result of this movie, wished to prevent the movie from ever being made, sending yet another robot back in time to prevent Cameron from directing it. Instead, Terminator 3: Rise of the Machines was released in 2003 and directed by Jonathan Mostow. Although Cameron is credited for writing it, he only created the characters. Since then three other movies have been made, all with different directors, and all critically panned compared to the Cameron films.

#1979: History

April 11, 2018



THE PUBLIC EVENTS OF THE LAST THREE MONTHS ARE OF THE CLASS WHICH WILL GO INTO ITS PERMANENT HISTORY. WE HAVE BEEN LIVING IN AN ATMOSPHERE OF HISTORY WHICH WILL BE IMMORTALLY PRESERVED. EVEN THE BRIEF SERIES OF IMPORTANT DATES TO BE COLLATED FOR THE USE OF THE SCHOOLBOYS OF CENTURIES HENCE WILL CONTAIN THE DAY OF THE ASSASSINATION, AND THE DAY OF THE DEATH OF PRESIDENT GARFIELD.

THE INTERMEDIATE EVENTS CO-RELATED, LIKE THE DEFEAT OF ROSCOE CONKLING, WILL BE OF GREAT INTEREST, BUT WILL SCARCELY BE LIKELY TO STAND PROMINENTLY OUT FROM THE PAGE OF HISTORY WRITTEN IN 1881. TO US WHO HAVE BEEN THE WITNESSES, SO TO SPEAK, OF THE TRAGIC INCIDENTS OF THE TIMES, IT SEEMS ENTIRELY PROBABLE THAT FUTURE GENERATIONS WILL EAGERLY SCAN EVERY FEATURE OF THE RECENT BEREAVEMENT WHICH THE NATION HAS SUFFERED.

HOW ACCURATELY WILL FUTURE GENERATIONS KNOW THE IMMENSE VOLUME OF GRIEF AND SORROW WHICH HAS ROLLED OVER THE LAND? WILL THOSE WHO COME AFTER US EVER BE ABLE TO UNDERSTAND THE EXTENT OF OUR LOSSES? IS THERE ANYTHING IN THE FIRST CENTURY OF OUR HISTORY—EVEN THE DEATH OF THE GREAT LINCOLN—WHICH CAN BE USED AS A PARALLEL?

PERHAPS A CAREFUL READING OF THE DAILY PAPERS OF THE PRESENT PERIOD MAY GIVE SOME FUTURE ANTIQUARIAN A FINE IDEA OF THE FEELINGS OF THE NATION DURING THE PAST SUMMER. BUT THESE JOURNALS ARE SO LARGE, SO FULL OF DETAIL, THAT WE IMAGINE THE COMING AMERICAN WILL NEVER FIND TIME TO READ THE RECORD. HE MUST DEPEND ON A BRIEF STATEMENT, MEAGERLY COMPILED BY SOME DRY AND TEDIOUS HISTORIAN.

—THE BLOOMINGTON DAILY PENTAGON
SEPTEMBER 30TH 1881



HISTORIANS: We've decided to trim the past down to make things more manageable. Using BCE/CE, would you rather we lose the odd-numbered or even-numbered years?

Explanation

This comic quotes a lengthy section of the Bloomington Daily Pantagraph's September 30, 1881 issue. The tragic event referenced throughout is the assassination of President James A. Garfield. Interestingly, the article is about how closely studied the incident will or will not be in the future. Garfield's assassination is rarely more than a quick note in a history class, leaving only the "dry and tedious" historians to comb through the details.

The writer also notes that vast quantities of accounts exist of the national grief and trauma caused by Garfield's murder, and wonders whether students in the future will bother to read those accounts to understand it, or simply let historians sum it up without conveying the vastness of the response. That fear at least did prove well-founded; most students are not aware of the fallout of the assassination, or indeed, of Garfield at all. Cueball and Megan are discomfited by the fact there exists a vast, untapped store of information that they have never read, about an event they know little to nothing about despite it apparently causing nationwide trauma. This leads to a larger point about the vastness of history, and the impossibility of learning all of it.

The article itself references other events that would have been in recent memory at the time of publication and draws some conclusions about which will be considered more important in the future.

For example, it cites the defeat of Roscoe Conkling as a serious event that would fade in importance when compared to Garfield's assassination. Conkling was a senator in Garfield's party who resigned in protest of Garfield's policies assuming that he would easily win re-election by the state legislature--but then failed to achieve re-election due to party factions and political infighting.

Interestingly a comparison of Google search frequency for the years 2004-2018 shows that Garfield is indeed searched for many times more often than Conkling. Conkling's failure to be re-elected by the New York state legislature, which seemed so vitally important at the time, is summarized by a brief two sentences near the bottom of Conkling's Wikipedia article and not even mentioned in the biography's summary. So the writer does appear to be correct that Conkling's re-election defeat was an episode that was of high importance as a current event that in the future was to become not much more than an obscure footnote.

The writer speculates that there may not be any event in American history that matches the level of grief caused by Garfield's assassination, not even that of Lincoln. Here the writer is further off the mark, because in current historical memory, the Lincoln assassination is still a towering, defining event, whereas Garfield's is, comparatively speaking, a footnote.

The bolded sections of the text emphasize some of the main points of the article for the modern reader and may

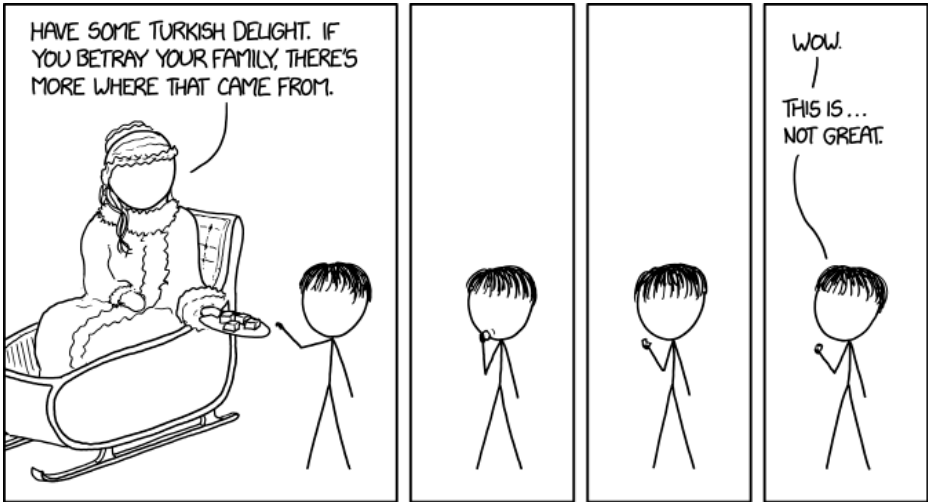
also be another way Munroe makes the point that future readers are unlikely to have the patience to read lengthy, detailed explanations of past events. If they have time to pay attention at all, future readers will want the essence boiled down to a few major highlights.

The title text indicates that there is more information about the past than can be researched by the manpower of available historians at this time. For whatever reason, be it lack of funding to carry out research or lack of interested people becoming historians, the facetious solution is to just ignore events of either even or odd numbered years. This would essentially halve the amount of data to go through and the amount of time to go through it, but it would be at the detriment of our understanding of all of the context of said events. As an example World War 2 started and ended on odd years, but some of the most tide-turning battles (Fall of France, most of Stalingrad, D-Day) happened on even years.

Although this format with small panels above and below a larger one has been seen before, there could be an extra joke this time, if it is seen as if there were originally five panels to the comic, but the second and fourth (the even ones) were removed.

#1980: Turkish Delight

April 13, 2018



THE NARNIA BOOKS GAVE ME A REALLY UNREALISTIC IMPRESSION OF HOW GOOD TURKISH DELIGHT TASTES.

I take it Narnia doesn't have Cinnabons? Because if you can magic up a plate of those, I'll betray whoever.

Explanation

The Lion, the Witch and the Wardrobe is a fantasy novel by British novelist C. S. Lewis, the first published and best known of seven novels in The Chronicles of Narnia. In it, a group of four sibling children discover another world called Narnia. At the beginning of the story, the land is in a perpetual winter caused by the White Witch (the antagonist of the story). One of the children, Edmund Pevensie, is approached by the White Witch and offered Turkish delight, a type of confection, in exchange for leading the other children to her. What the book says and what the movie leaves out is he doesn't know the sweets are enchanted by the White Witch to make the eater want them the more they eat them. Not a full mind control, but more of a strong urge to get more.

Turkish delight is very different from typical confections found in the modern Western world and isn't very popular in the United States. The primary flavoring agent of Turkish Delights, rosewater, has a strong perfume-like taste and is generally considered an acquired taste for western palates. Randall, who has made comics about being unimpressed by food in the past, comments that he was very disappointed when he tried Turkish delight, especially after having read in the novel about how delicious the characters considered it. If he were in Edmund's shoes, he would not have been persuaded.

It is not uncommon for present-day Narnia fans to be disappointed when they try Turkish delight, as different

as it is to modern confections. However, in the late Victorian era when Lewis grew up, Turkish delight was very popular in England. Because it was nearly impossible for local confectioners to make properly, it had to be imported from Turkey, at great expense, making it a status symbol for the wealthy and a rare treat for those with less money. When Lewis wanted to come up with the perfect temptation for Edmund, he drew on his own childhood memories of a favorite rare and expensive treat--which would have been even harder to come by because of sugar rationing during World War II, when the story was set. It also serves to emphasize how powerful the White Witch is for her to be able to offer such an expensive and hard-to-obtain treat so easily.

Cinnabon (referenced in the title text) is a popular chain restaurant in the USA which serves mostly cinnamon buns covered in a thick, sugary glaze. The chain is not well known in Britain, but has recently opened a few restaurants, mainly in the London area. (A more common UK equivalent of the cinnamon bun is the Chelsea bun.) There are presumably no branches of Cinnabon in Narnia.[citation needed] Randall is saying that he finds cinnamon buns delicious, to the point where he would betray anyone for them. It should be noted that, in the books, it was Edmund who requested the Turkish Delight, implying that they're his favorite treat. Thus, had it been Randall instead of Edmund, he very well could have requested cinnabons.

#1981: Rickrolling Anniversary

April 16, 2018



Want to feel old? The 'want to feel old?' factoid meme dates back to around **2011**, closer to the **Bush/Kerry** election than to today.

Explanation

Cueball tells Megan that by the release of this comic in April 2018 it is the 10th anniversary of the peak of rickrolling. Rickrolling is a bait and switch internet prank, in which a person is tricked into clicking on a link under some pretext, and is diverted to a music video of Rick Astley performing his 1987 hit "Never Gonna Give You Up". This trend began in 2007, but reached a peak in about April 2008 when, as an April fool's day prank, Youtube linked all its featured videos to Never Gonna Give You Up. At nearly the same time, the New York Mets held a public vote to choose their 8th inning sing-along, and fans organized to vote for "Never Gonna Give You Up". This coincided with a sharp peak in searches for "Rick Astley" and related terms.

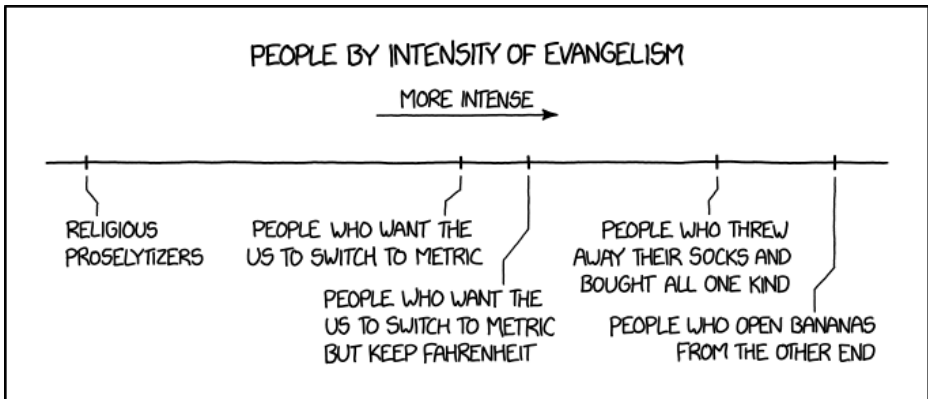
When Cueball points out how long ago this happened, Megan expresses surprise that the phenomenon was that old, then expresses a half-hearted happy anniversary wish. After a beat panel Cueball concludes "We've known each other for so long", which is both a poetic affirmation of his friendship with Megan, and a line from the song, which effectively turns this conversation into its own version of rickrolling.

The first reference to rickrolling in xkcd was in 351: Trolling from 2007, where Astley himself was Rickrolled by Black Hat. Black Hat then later uses Astley to show his girlfriend Danish how Rick rolls in 524: Party, a New Year party from the end of 2008.

The title text refers to another old xkcd meme of giving snippets of information to the reader that make them feel old. Although comics such as 218: Nintendo Surgeon in 2007 refer to facts that could make you feel old, the first comic directly build around factoids to make one feel old in xkcd was 891: Movie Ages in April 2011. This was 7 years before the time of publishing. The Bush Kerry election was in November 2004, 6½ years before that comic, making the title text statement that the beginning of this meme is closer to that election than today. This is the way most of these make you feel old comics are built.

#1982: Evangelism

April 18, 2018



The wars between the "OTHER PRIMATES OPEN THEM FROM THE SMALL END" faction versus the "BUT THE LITTLE BIT OF BANANA AT THE SMALL END IS GROSS" faction consumed Europe for generations.

Explanation

In this comic, Randall presents a line plot where causes are listed, in increasing order, by the intensity of the evangelism of their advocates. Evangelism, in Christianity, is the commitment to or act of publicly preaching of the Gospel with the intention of spreading the message and teachings of Jesus Christ. The notion of spreading the faith by preaching is both historically and doctrinally deeply rooted in Christianity, so the notion of persistent and committed Christian missionaries is a well-known phenomenon. Over time, the term “evangelism” has come to be used more generally for zealous advocacy of anything, with the implication that the commitment to spread their message is similar to religious evangelism.

The first punchline is that religious proselytizers are unexpectedly the least zealous of all the groups mentioned on this chart, despite being the origin of the term.

As the graph moves from left to right, the issues at stake have less and less impact on the life of someone who “converts”, but the intensity and fervor of those spreading the cause increases. This is counterintuitive, which is the joke.

Below, each of the points on the chart, as well as the title text, is discussed.

Religious proselytizers are the best known evangelists, and the term “evangelism” originally applied only to them. Christian faith remains roughly as popular as ever, but Christian evangelism has become less common and less accepted in the public sphere in recent decades, and often only practiced in specific venues. Randall contrasts them in this strip with four other groups which he finds to be more intense in their “evangelism”.

Unlike most of the world, the US uses US Customary units instead of metric units. The vast majority of the world population (and many within the country) wish for the US to change. In truth, federal law has declared the metric system to be the preferred system in the US since 1975, but includes no mandates for enforcement, meaning that social and economic inertia keeps customary units in general use. Though the US now uses SI units in many areas, particularly in technical and scientific settings, most Americans deal more with US Customary units in their day-to-day lives. Many advocates (both in and out of the US), argue that the metric system to be more logical and usable, and consider it to be unreasonable that the world's largest economy remains out of step with what has become the global standard for measurement.

Randall has made a conversion chart for helping US people with the confusing metric units: 526: Converting to Metric.

Pro-metric people who wish to keep the Fahrenheit scale rather than change to Celsius are ranked as slightly more

evangelic. A common argument for keeping the Fahrenheit scale is that it roughly matches the range of habitable temperatures for humans (0°F equating to “really cold” and 100°F to “really hot”) and is therefore more intuitive when discussing weather. Fahrenheit also has smaller degrees than Celsius, so temperatures can be cited more precisely while still using whole degrees.

To many people, making the shift only partially may seem inconsistent—and yet the people arguing for this are even more ardent than those that wish to shift entirely, perhaps precisely because of this apparent strangeness.

Fahrenheit versus Celsius has been the topic of 1643: Degrees and 1923: Celsius.

Since socks are generally worn in matched pairs, both socks in a pair have to be located before they can be worn. When socks are separated (which commonly happens when washing, drying and sorting them), locating both can be an annoyance, and losing one renders the other useless until it is located. People who lose one sock are usually unwilling to throw the other out, in case its mate is located, leaving them with a collection of unmatched socks to deal with. This is a common enough problem to have been researched by scientists.

This problem can be solved by buying only one type of sock, with a uniform design and pattern. Because socks can usually be worn on either foot, this makes sorting

socks after washing unnecessary, since any two socks form a pair, and losing one is less vexing, since you can never end up with more than one unmatched sock (and losing another one just evens the numbers again). To many people, though, this solution is unappealing. Many people find it aesthetically boring to always wear the same color of socks, and it risks having to either wear socks that don't match the rest of your clothes, or stick to a much more limited color palette for your whole wardrobe.

Randall previously referenced this idea in the xkcd survey (see 1572: xkcd Survey) from September 2015. It included this question:

The most evangelical group Randall includes are the people who open bananas from the "other" end. The majority of people peel bananas by using the stem as a lever to open the peel, then pulling the peel back by sections. An alternate method is to pinch the calyx and separate the peel into two halves.

An oddly committed subculture has grown up, insisting that opening the calyx is the "right" way to eat bananas, using an assortment of arguments in an attempt to back up their point. These arguments don't appear convincing enough to change the habits of the banana-eating public at large, but that doesn't appear to make advocates less committed to this extremely low-stakes topic.

The comic's release date on April 18th, is likely correlated with this day's assignment as the official

“Banana Day” in the US. (However, at the time of release of this comic, this day was not mentioned on the Wikipedia list of food days in the US).

The title text categorizes the two sides of the banana conflict by their most common arguments. While primates do not eat bananas in the wild, in captivity, some have been observed to open them away from the stem, so "OTHER PRIMATES OPEN THEM FROM THE SMALL END" is advanced as an argument for why this method is 'correct'. "BUT THE LITTLE BIT OF BANANA AT THE SMALL END IS GROSS" is the most common retort. Opening a banana from the small end typically leaves part the flower tip embedded in piece of mashed fruit, which many consider to be "gross". This is obviously a subjective judgment, but is sufficient reason to find the method unappealing.

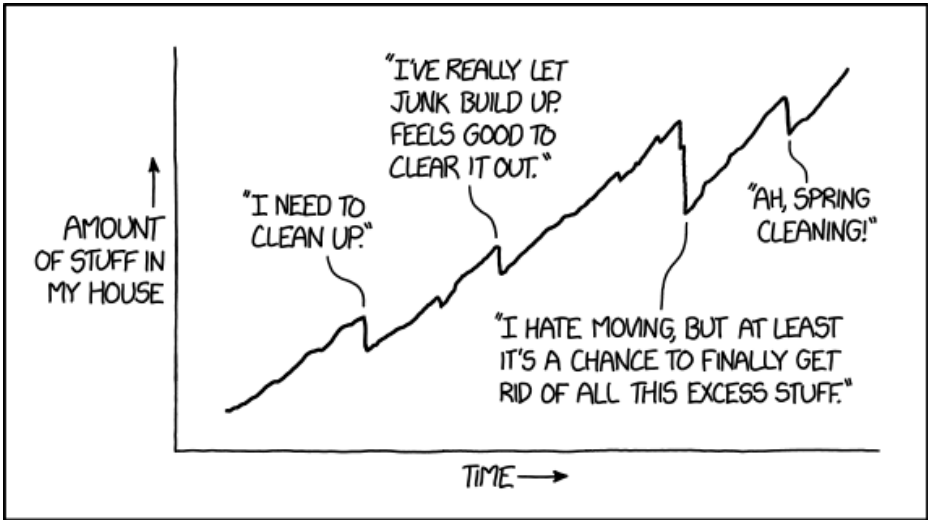
Satirically claiming that wars between these factions "consumed Europe for generations" likely refers to the wars between Catholic and Protestant factions, which did, in fact, consume Europe for generations. This ties the dispute back to the original meaning of "evangelism", suggesting that this issue ignites a fervor usually reserved for religious belief. At the same time, it's likely intended to satirize those wars themselves. The notion of going to war over such a trivial and fundamentally unimportant issue is clearly ridiculous. From an outsider's perspective, the notion of going to war over which faction of Christianity would have greater influence could easily seem similarly trivial.

The entire "correct banana end" discussion could be a reference to the wars between the Blefuscudians, who opened their eggs at the big end, and the Lilliputians, who broke their eggs at the small end, as told in Jonathan Swift's epic novel *Gulliver's Travels*. This in turn is the origin of the terms "Little Endian" and "Big Endian" which were much debated in circa 1980's computer architectures — which may also have been on Randall's mind.

Randall's thoughts on the problems with opening bananas could also explain why this fruit, which many find very easy to peel and consume, is listed in the middle of the easy/difficult scale in the 388: Fuck Grapefruit chart.

#1983: Clutter

April 20, 2018



I'M STARTING TO WORRY ABOUT MY STRATEGY FOR DEALING WITH CLUTTER.

I found a copy of *The Life-Changing Magic of Tidying Up*, but the idea of reading it didn't spark joy, so I gave it away.

Explanation

As the graph shows, the amount of junk sitting around Randall's house is on an ever-increasing trend. Thus, it will continue to pile up and cause problems.

Randall cleans up sometimes, thinking that he is returning to the same baseline amount of stuff each time, but it is not actually effective enough to keep up with the cluttering trend, and hence his worry.

The four places on the graph where the amount of stuff decreases reference common times when people clean up and get rid of junk or excess stuff. This includes:

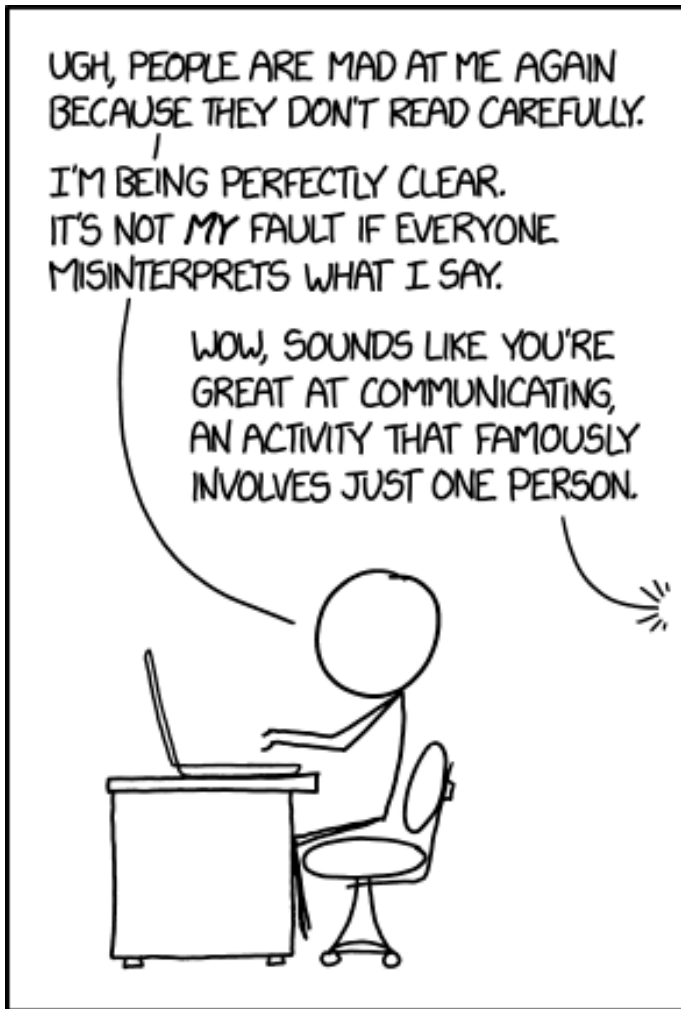
- The satisfaction many people feel from getting rid of things and making the remaining items look neat.
- Moving, a time when most people will get rid of items they no longer need and use, rather than packing them up and moving them to a new home where they will once again cause clutter.
- Spring cleaning. In many areas with a harsh winter, it is common to clean in the spring when it is warm enough to open windows for dusting, after months of building up smoke or soot from fires to keep the house warm. In other cultures where the year starts in the spring (a time of rebirth) there are traditions of cleaning up before the start of the new year. This may also mean that this graph takes place over the course of a single year, a disturbing fact if the graph continues this way.

Although not mentioned in the quotes, it is also common in the United States to clean up and donate items (for instance to Goodwill) on December 31st, right before the New Year, to gain the charitable donation benefit on their taxes for that year.

The title text refers to the book *The Life-Changing Magic of Tidying Up: The Japanese Art of Decluttering and Organizing* by Marie Kondo. The main concept of the book is that one should gather all belongings and only retain items that "spark joy". Ironically, the thought of reading the book didn't spark joy for Randall so he decided to donate it. Thus, one of the few things that he did get rid of was something that if he had kept and put into practice could have helped him actually reduce his clutter.

#1984: Misinterpretation

April 23, 2018



"But there are seven billion people in the world! I can't possibly stop to consider how **ALL** of them might interpret something!" "Ah, yes, there's no middle ground between 'taking personal responsibility for the thoughts and

feelings of every single person on Earth' and 'covering your eyes and ears and yelling logically correct statements into the void.' That's a very insightful point and not at all inane."

Explanation

Cueball is complaining that people are mad at him again because of a misinterpretation of his statements. This is referenced by the comic's title. He complains that since (he believes) he is being perfectly clear, it cannot be his fault that everyone misinterprets him. The off-screen voice sarcastically agrees that communication is an activity that only involves one person; in fact, of course, it famously involves at least two.

Cueball speaks as though his communications are complete and perfect once he has finished making them. The reality is that communication can't be considered complete until the message has also been received and understood. Cueball is failing to take into account the need for partnership between sender and receiver, and doesn't realize that the problem may well be in the way he carries out his side of the transaction rather than in the way everybody else is carrying out theirs.

In the title text, Cueball then answers that he cannot possibly account for the many possible interpretations which the message, potentially reaching the whole world, could acquire. This is an example of the Nirvana fallacy. Cueball's idealized solution is to consider how every person on Earth would interpret the message, so Cueball rejects doing anything less as insufficient; however, actually figuring out how every person on Earth would interpret the message is unfeasible, so Cueball doesn't do that either. The reply comes once again sarcastically,

deriding his point and saying that a middle ground between taking up such an effort and entirely avoiding it must be reached.

This avoidance is phrased using an analogy as “covering your eyes and ears and yelling logically correct statements into the void”, implying that no one would understand the logical sentences (thus the void), and would instead read them more naturally – and also that ignoring the appalled reaction of listeners to their own interpretation of the sentences is similar to covering your eyes and ears. This action makes communication more difficult through the popular[citation needed] means of speech, text and sign language. If the hands are occupied with covering either part, then Braille communication is also impossible. Therefore, the action of “covering your eyes and ears” is a metaphor for deliberately making it more difficult to communicate with oneself. The simile might also mean that Cueball subconsciously rejects criticism as it would hurt his ego.

It is clear that Cueball is acting as a straw man to further Randall's point, and the off-panel character is portrayed as the (sarcastic) voice of reason.

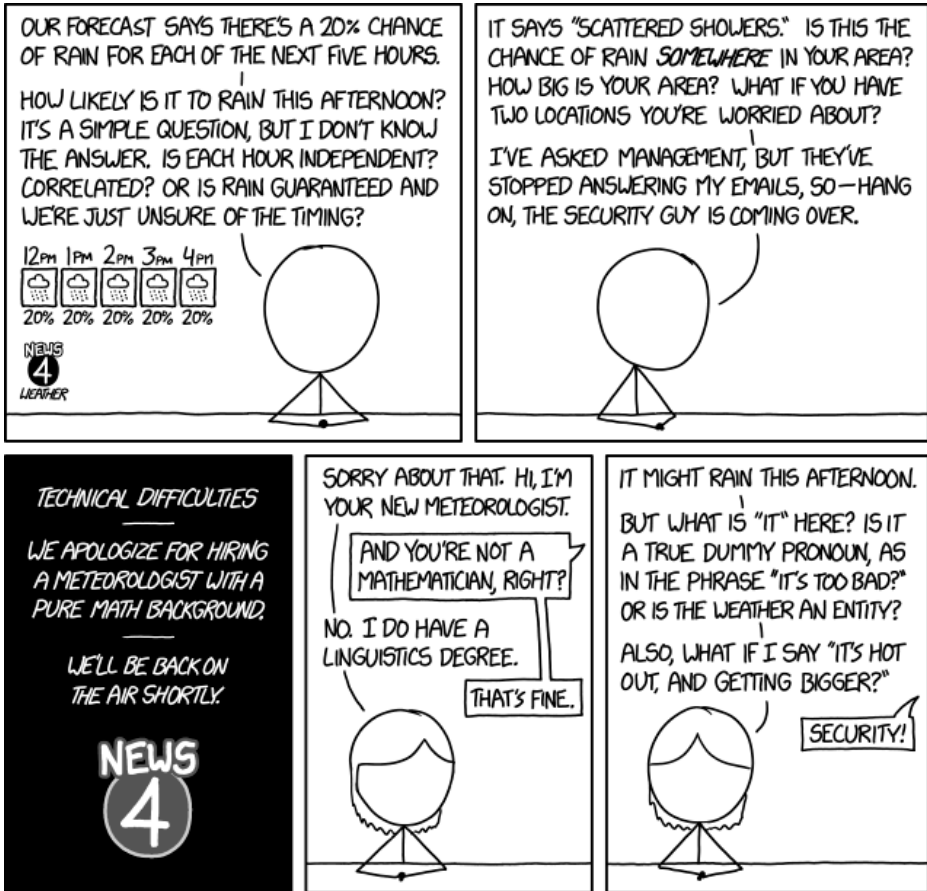
Randall returns to a recurring theme in his comics, regarding, in contexts of communication, the responsibility of the speaker for how they are interpreted. Having gradually gotten less subtle, this theme is now laid bare, there being no joke other than the sarcasm. What follows is a chronological history of this theme.

- Much earlier than the other comics below, but related, 169: Words that End in GRY is a surreal reprimand upon people who act smug when their bad communication is misunderstood.
- The title text of 1028: Communication notes that “Anyone who says that they’re great at communicating but ‘people are bad at listening’ is confused about how communication works.”
- The title text of 1860: Communicating also asserts that the responsibility of a misunderstanding lies with the speaker, not the listener — a theme explored in the comic via the character Humpty Dumpty.
- The comic 1911: Defensive Profile implies that a person who boasts of having “no filter” in their (social media) speech is actually merely insecure about making people mad with their statements.

This theme is part of the larger category of comics about social interactions.

#1985: Meteorologist

April 25, 2018



Hi, I'm your new meteorologist and a former software developer. Hey, when we say 12pm, does that mean the hour from 12pm to 1pm, or the hour centered on 12pm? Or is it a snapshot at 12:00 exactly? Because our 24-hour forecast has midnight at both ends, and I'm worried we have an off-by-one error.

Explanation

Although we're constantly exposed to them, many (most?) people don't understand the details of how to properly interpret weather forecasts. But even beyond the normal questions, there can be much more complex issues hiding beyond those (though most people will not care for those). This comic takes this to the ridiculous extreme of the weather reporters coming from some other profession where you look into those questions. It shows questions asked by three different people with different backgrounds: mathematics, linguistics, and (in the title text) software development. While some of those questions have actual answers (which you'd expect someone working in that job to know, such as the definition of "scattered showers" and how it's determined, what a "chance of rain" means, and so on), each professional finally ends up with questions that are almost disturbing in how they cannot be answered. (So management ends up calling security to remove those announcers.)

It should be pointed out that hiring someone without any meteorological training to read the weather does not make them an actual meteorologist, no more than say hiring a bricklayer as a doctor would actually make them a real doctor.

Questions from the pure math meteorologist[edit]

The first meteorologist, Cueball, has a background in pure math. His forecast states that each of the next five hours has a 20%

chance of rain. As a mathematician he sees how limited that information is. There is no information about whether or how those probabilities are correlated. This becomes obvious if you ask the question "How likely is it to rain this afternoon" (a question even some non-mathematicians might be interested in). Cueball states that he does not know (as no one only getting the information about 20% rain in each hour can know). And then lists some scenarios that all fit the description, but have totally different results for "How likely is it to rain this afternoon?"

The first thing a mathematician would ask (and Cueball does here) is asking if those 5 events are independent. Events are independent if the outcome of one of them is unrelated to the outcome out of the others, i.e. knowing whether it rained at 3 pm has no effect on whether it rains at 4 pm, in which case the probability of any rain over the 5 hours is $1 - (1 - 0.2)^5 = 67.2\%$. (Rain is very seldom independent, as usually having rain in one hour increases the chance to rain in another hour, as systems of rainy weather usually persist for many hours). Another common extreme in probability theory is a set of mutually exclusive events. In this example that would be the scenario that the chance of rain is $5 \times 20\% = 100\%$, but it will only rain in exactly one hour and not rain at all for the other four. (Also possible but quite unlikely). This is what the mathematician was referring to by, "Is rain guaranteed and we're just unsure of the timing?"

In the second panel he continues to discuss what scattered showers means. Like most of the other weather terms in this comic, the term "scattered showers" is one whose technical definition is largely unknown but appears simple enough that most people would assume they understand what it means. "Scattered" refers to when the rain covers roughly 30–50% of the

area at a given moment. To somebody who doesn't know this, like the first meteorologist, there's still the very valid question of how likely it is to rain in a specific spot (is it 30–50% of the total probability, or is it more than that because showers move and sweep out a larger area?), and how this is affected by the previous chance of rain. Not to mention, the percentage that defines "scattered showers" implicitly assumes a surface area that is accounted into the percent. Cueball rightly asks clarification on how large the location used to determine "scattered showers" is.

While the all but the last question of the first part of the second panel can be answered by looking up their definitions, the last one is "What if you have two locations you are worried about?" This is an extremely complex question. Because there is no chance at all to answer this question from the answers of the previous questions or even from most other data a forecast might usually produce. To answer this you'd need the raw data from the ensemble forecast in order to specifically look at the correlation between weather at those two locations. Simply looking at the averaged result won't help.

Finally in that panel Cueball begins to explain that he has asked the management about these things, but that they have stopped replying to his e-mails. At this point he spots the security guy coming over, and the screen goes black in to a technical difficulty screen that excuses this behavior to the viewers. It is implied that the security guy came over to force Cueball to leave the set, because he has been fired for confusing the viewers.

Questioning these things on air is likely confusing to the viewers, although they are all valid questions. But this may lose viewers and the news network is afraid of this. The technical difficulty panel

further cements this, apologizing for hiring a person with a pure math background. Often seen as one that do not understand how to talk to regular people.

Questions from the linguist meteorologist[edit]

When they get back on air, the new meteorologist Blondie steps in. The management enquires (on air) to make sure she is not also a mathematician. She denies this but adds that she does have a linguistics degree, which the management thinks is fine, and thus believes they have prevented the same problem. However, Blondie quickly proves them wrong, as she goes into a linguistic tangent about the true meaning of the word "it" as referring to the weather. After one panel of this the management calls for security again.

While, at the most basic level, human speech is broken into subject, object, and verb; for some reason in English we are capable of producing and comprehending speech without objects or verbs, but there is a certain "resistance" to speech without a subject. If you were in the passenger seat of a car and spotted some deer nearby, you could simply say "Deer." rather than "There is a deer over there", deer being the subject of the sentence. However, if you noticed that it had begun to rain, you could not simply say "Raining." on its own. Feel how that sentence just seems weird? Hence we have developed the tendency to use the filler word "it"; despite the fact that when we say "It's raining.", the "it" is not a reference to the clouds producing the rain, but the general state of the rainfall around us. (McWhorter, John. Understanding Linguistics: The Science of Language. <https://www.thegreatcourses.com/courses/understanding-linguistics-the-science-of-language.html>)

The first question is again quite harmless, and both possible answers ("it" being a dummy pronoun or referring to the weather) are valid answers, but the second question is much more disturbing.

In "It's hot out, and getting bigger" the first part of the sentence might be a dummy pronoun or it might reference the weather. But the second part breaks it: With a dummy pronoun "getting bigger" would be the impersonal action, which is not what is meant. It is referencing something (the hotness, that is getting bigger). But if the it references this entity in the second part, by grammatical rules it would also have to reference that in the first part. But "The hotness is hot out" makes no sense at all. (An alternative explanation is that the sentence is referring to the fact that if a dark (so as to absorb light energy from sunlight and convert it to thermal energy) object is placed outside in sunlight, it will heat up and undergo thermal expansion.)

This is again a common occurrence with informal speech: From a grammatical point of view, it is pure non-sense. But it still has meaning people understand. So if you want a proper descriptive grammar, it needs to cope with those cases. But then most such informal sentences would be special cases. (Case in point: What is the grammatical function of the "out" in that sentence?)

Questions from the software developer meteorologist[edit]

In the title text, the news station has made the same error once more by hiring a software developer. The developer states concerns about the feasibility of the time system used to correlate to the weather patterns. Labels like "12pm" or "1pm" appear simple and clear, but because developers frequently have to deal

with what these labels mean exactly, the new meteorologist begins to wonder what time period is actually meant on a per-hour forecast. Does 12pm refer to the hour from 12 to 1pm, from 11:30am to 12:30pm, or only to the weather precisely at noon?

The software developer also worries about an off-by-one error, which is a common error in software development which occurs when boundary conditions include one element too few or too many. For example, when counting by 24 once every set period, it is common to forget whether the count should stop at 23 or at 24, especially if the number 0 (midnight) is included. In the 24-hour forecast, this means that there would be 25 hours represented every day, and these extra hours would add up and put the forecast one more hour off with each progressive day.

This worry is probably absurd because the inaccuracies would quickly build up and be noticed, and even if they weren't, the time would eventually be further into the future than the forecast models could supply. At least these concerns are less inane than the previous meteorologists', but they are all things the developer should have asked before they went on the air.

Answering the meteorologists' questions[edit]

Management would certainly answer the mathematician's questions! The questions themselves have been asked of meteorologists before. The National Weather Service (NWS), a unit of the United States National Oceanic and Atmospheric Administration (NOAA), has published relevant answers for probability of precipitation, as well as timing and the meanings of particular forecast words. The naming is also addressed here.

Regarding probability of precipitation, NOAA forecasts give the

probability that it will rain at all at any given point in an area. To rephrase it, it is the probability of rain occurring at all within a forecast area multiplied by the percentage of area affected by the rain. The "forecast area" is a clearly defined area of land and can be seen in the map of any official NWS forecast. Here is an example.

Regarding the timing of the forecast, an hourly forecast gives the probability for each particular hour, stretching from the time listed to right before the next hour listed. So, the forecast for noon describes the time period from noon to 1pm. The forecasts for individual hours can be correlated; for this reason, the NOAA generates forecasts that stretch over longer time periods, giving a useful estimate for that time range. Thus, the chance of rain for "Today" specifically means: what is the chance of it raining at any given location during any time between 6am and 6pm?

Regarding phrases like "scattered showers", this specifically means a 25-54% probability of precipitation from convective cloud sources. Other phrases, and when they are used, are detailed in the chart at the end of this PDF.

So, to conclude:

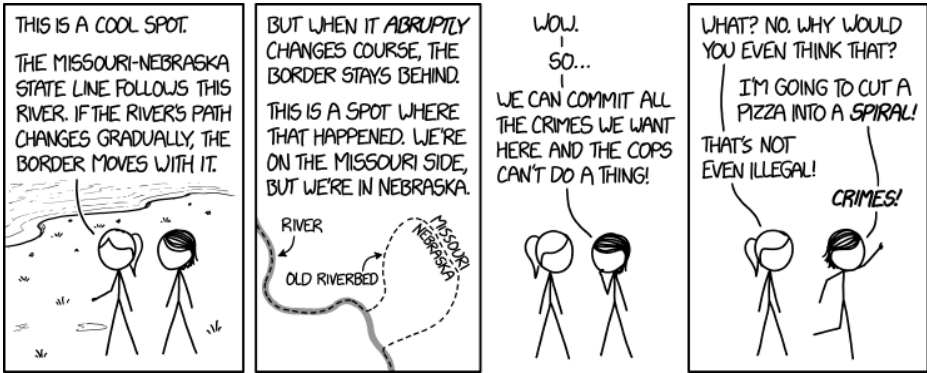
- "How likely is it to rain this afternoon?" We don't know; you need to show the hourly forecast, not the 12 noon to 4pm forecast.
- "Is each hour independent? Correlated?" Hourly values are given for that hour only. They can be correlated, hence why they can't be used to calculate the answer to "How likely is it to rain this afternoon?"
- "Is rain guaranteed and we're just unsure of the timing?" You

cannot tell from the data given. It's possible (though unlikely), that this is the case.

- "It says 'scattered showers.' Is this the chance of rain somewhere in your area?" Yes, it is, and it means the rain will come from convective cloud sources with a probability of precipitation somewhere between 25 and 54%.
- "How big is your area?" It's detailed in the forecast the mathematician would be reading from.
- "What if you have two locations you're worried about?" Then all chances are off. While the other open questions like "How likely is it to rain this afternoon?" might have an answer management could supply, for this they do not really have any chance at all.
- "Hey, when we say 12pm, does that mean the hour from 12pm to 1pm, or the hour centered on 12pm? Or is it a snapshot at 12:00 exactly?" It means the hour from noon to 12:59pm.
- We have been effectively nerd-sniped.

#1986: River Border

April 27, 2018



I'm not a lawyer, but I believe zones like this are technically considered the high seas, so if you cut a pizza into a spiral there you could be charged with piracy under marinaritime law.

Explanation

This strip is about the complexities that arise when political boundaries are mapped to geographical features. Ponytail explains to Megan that many borders run along rivers, which can become tricky, since the courses of rivers can change over time. The specific example Ponytail uses is a segment of the Missouri-Nebraska state border which runs along the Missouri River. She explains that, when the course of rivers changes slowly, state boundaries generally move with them, but this section had changed abruptly, due to a meander cutoff, and the border didn't move with it. That means that they are on a part of the Missouri side of the river that in fact belongs to Nebraska.

Rather than simply being interested in this geographical oddity, Megan mistakenly concludes that she could break the law in this area without consequences. Ponytail immediately points out isn't true, but Megan seems to ignore her.

The notion of a "legal dead zone" in which laws either don't apply or can't be enforced intrigues many people, likely because people who've lived under a system of laws their whole lives often wonder what it would be like to be unrestricted by any legal code. While Megan's assertion in this case is wrong, there are a number of cases in history where areas, either in theory or in fact, fell beyond the reach of normal laws.

- In 2005, an article in the Georgetown Law Review noted that, due to a mismatch in state borders and federal districts in one region of Yellowstone National Park, it would theoretically be impossible to create a jury to convict someone for crimes committed in that region. This theory has never been tested, and it's not sure how the courts would respond, but that region has been referred to as a legal dead zone. (What If? 2 references this region, and 2702: What If 2 Gift Guide recommends bringing a law-enthusiast friend here.)
- Bir Tawil, a region along the border between Egypt and Sudan, is claimed by neither country as a result of the Halaib Triangle border dispute. This makes it unlikely that either country would try to enforce its laws in this region (though the region is uninhabited, making the potential for crimes limited).
- Kowloon Walled City was an enclave in British-controlled Hong Kong. The original treaty gave China the right to administer this enclave, but they were driven out by the British. Following World War 2, China announced its intention to reclaim the enclave, setting up a decades-long stand-off in which neither side administered the area, making it effectively lawless. Unlike the earlier examples, this loophole was quickly taken advantage of by war refugees who built a dense city there, out of reach of the authorities.
- Border disputes between countries sometimes result in enclaves controlled by one country but fully surrounded by the other. That means that neither country's authorities can travel to the enclave without

crossing international borders. When that isn't allowed, the enclave is effectively beyond the reach of law enforcement. This is arguably the closest case to what's portrayed in this comic: if there are no bridges over that section of the river, then Nebraska police would find it somewhat inconvenient to get to the other side. In reality, though, there is no restriction against local authorities from travelling through a different jurisdiction to get to their own. Not to mention that, if Megan committed a federal crime in that region, national authorities could arrest her anywhere in the country.

- Areas of the oceans beyond either the 12-nautical-mile territorial waters or the 200-nautical-mile exclusive economic zone of any country's land are not under the jurisdiction of any country and fall under international maritime law, which has little to no enforcement. Although vessels in such areas theoretically fall under the laws of the country they're flagged in, enforcement of laws by most countries is nearly non-existent, sometimes leading to a nearly lawless region.

In the final panel, Megan reveals the "crime" she's excited to commit: cutting a pizza into a spiral. While unconventional, there's no law against doing so in any jurisdiction, making the entire point moot. Megan ignores this fact, simply shouting "crimes!", suggesting that her excitement about being free from the law is largely theoretical, rather than having specific crimes that she wants to commit.

In the title text, Randall claims/hypothesizes the disputed region is probably considered like the high seas, suggesting the pizza case would then fall under maritime law. Historically, the "high seas" have been the primary region that stands outside the jurisdiction of any specific authority. As a result, other areas that are similarly outside national boundaries, such as outer space, are often considered to be governed by maritime law, as it's the most convenient legal framework to use. "Pieracy" is a portmanteau of pie (another term for a pizza) and "piracy", and pizzas are often made with marinara sauce, so "maritime" law is rendered "marinaritime".

The region mentioned in the comic can be seen here at Google maps and is known as McKissick Island. In 1904, the U.S. Supreme Court confirmed in *Missouri v. Nebraska* that a sudden change of a river's course does not change any border. See: *Missouri v. Nebraska*, 196 U.S. 23 (1904).

Riverine Boundaries in Common Law and Surveying[edit]

This strip is alluding to the concepts of 'accretion' and 'avulsion' in boundary law.

Accretion is the gradual change of the location of a river or stream by erosion or addition of sediment through natural river processes. According to common law in the United States and elsewhere, if a river or stream location changes gradually, then the boundary line moves with the stream. In cases of pure accretion, it is possible for a parcel of land to be entirely eroded away on one

side of a river, and have material be added to the opposite side of the river. In such cases, one property owner could lose all their land.

An avulsion is a sudden change in the location of a river or stream, often due to flooding. In times of flood, a river can cut a new channel through surrounding land, which can create islands and oxbow lakes. According to common law, an avulsive change will not change the boundary of the land, as it is likely that the property is unchanged except for the new channel.

In the real world, however, river systems undergo both accretion and avulsion multiple times over any given period. This makes the determination of property lines along riverine boundaries one of the most complicated aspects of boundary surveying. An examination of a river boundary will require in-depth research of the local history of the river, including reviewing deeds, government survey plats, private survey maps, aerial photos taken over time, local landowners recollections and local lore. In situations where there is disagreement over whether an avulsive or accretive change happened, landowners may have to go to court for a suit to quiet title.

Further in-depth reading may be found in the US Bureau of Land Management's 2009 Manual of Surveying Instructions, Chapter 8, specifically pages 197-205. (See: PDF (37.7 MByte).)

Real-world examples[edit]

Often, borders defined by a river actually change. There are three methods to define a border:

- The border follows one of the river banks, often in reference to a

low-water mark. The exact location of the border is defined in a clear way - but one of the territories will lose terrain through erosion. When the river bends, erosion occurs at the outer bank and much less at the inner bank.

- The border follows the middle of the river.
- The most usual definition of a riverine border uses the talweg. The talweg (German for "valley path") always follows the line of the deepest points in the water body. Especially at river bends, the talweg is rarely in the middle of the river. Incidentally, the talweg also signifies the navigable zone of a river. In terms of natural borders, one counterpart of a talweg is the drainage divide, but these divides are hard to recognize on a map and rarely used to define a real border.

The Mexican-US-Border that follows the Rio Grande is one of the most prominent examples of an international border that needs meticulous regulation. Thus, the International Boundary and Water Commission was created. This commission was involved when the two nations rectified the course of the river, ceding equal amounts of land to each other. The Canada-US-Border is overseen by a similar commission. There is also a strange section on the border to Canada, which Randall mentions in the comic 1902: State Borders.

The border between Delaware and New Jersey veers from the median and talweg methods such that Delaware's border includes all the way to the New Jersey shore where the Delaware River is within what is known as the Twelve-Mile Circle.

One of the causes of the Iran-Iraq War was the dispute on shipping rights on the Shatt-el Arab river, and because the border

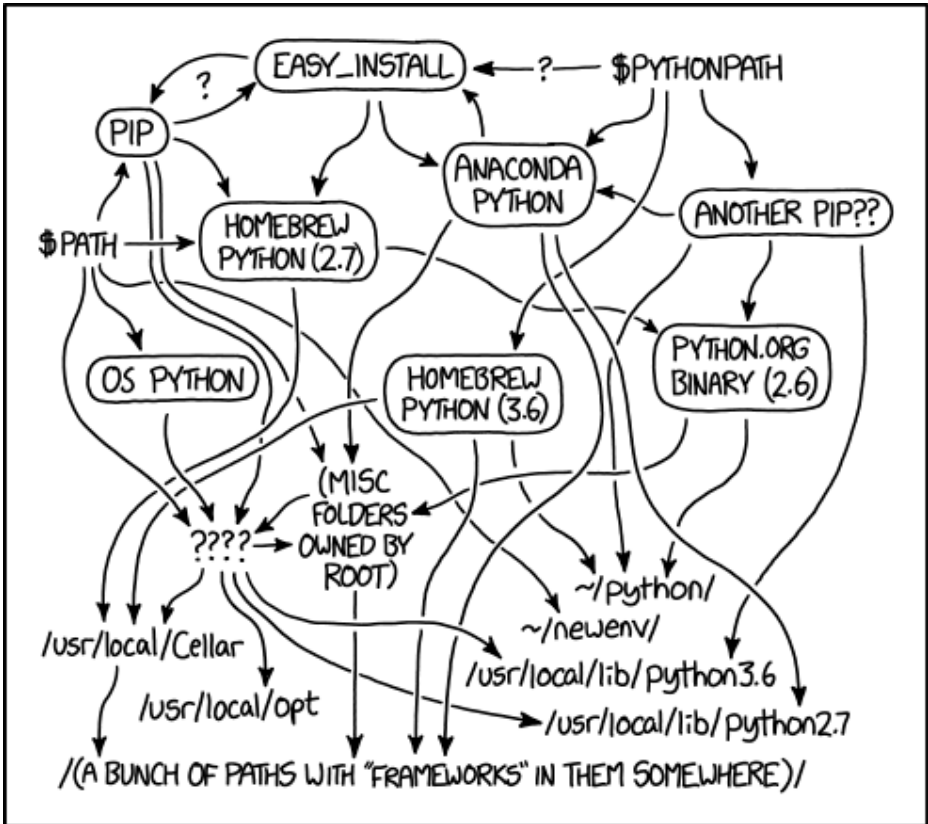
was defined as the low water mark at the eastern side of that river, Iranian shipping was severely restricted. So the Shah of Persia announced intent to ignore the 1937 treaty on shipping rights, following the convention of most riverine borders all around the world being defined by the talweg.

Between Switzerland and Italy, the border is, at most locations, defined by the actual drainage divide. Because the Theodul Glacier between Zermatt (Switzerland) and Breuil-Cervinia (Italy) is slowly melting, the drainage divide moves southwards, thus slowly enlarging the Swiss territory.

Most other national borders in Europe are defined today as fiat borders instead of following natural landmarks like rivers. If a river changes course now, the depicted situation would occur; however, most larger rivers have been rectified more than a century ago and thus don't often significantly change course.

#1987: Python Environment

April 30, 2018



MY PYTHON ENVIRONMENT HAS BECOME SO DEGRADED
THAT MY LAPTOP HAS BEEN DECLARED A SUPERFUND SITE.

The Python environmental protection agency wants to seal it in a cement chamber, with pictorial messages to future civilizations warning them about the danger of using sudo to install random Python packages.

Explanation

A development environment is the collection of tools used to create a computer program. It generally includes an interpreter, a package manager, and various libraries that the project needs. One such example is Python.

Historically, a computer would have only a single such environment, ie. only one copy of these tools installed, with all programs running off of it. However, people quickly discovered that this caused issues when said tools got updated and unintentionally break the programs. As an example, many programs still run on Python 2.7 (released in 2010) because Python 3.x changed things around so much that the effort to alter the program to run on it was deemed too much effort.

In an attempt to solve the above issue, the solution was determined to simply have each program have their own copy of the tools that they could be free to modify however they like without worrying about how it might affect other programs. Multiple tools were then developed intending to make it easier for a user to manage and keep track of the now-multiple environments, but it seems that for Randall this has simply created a new issue: he has lost track of which copy of Python his computer uses by default.

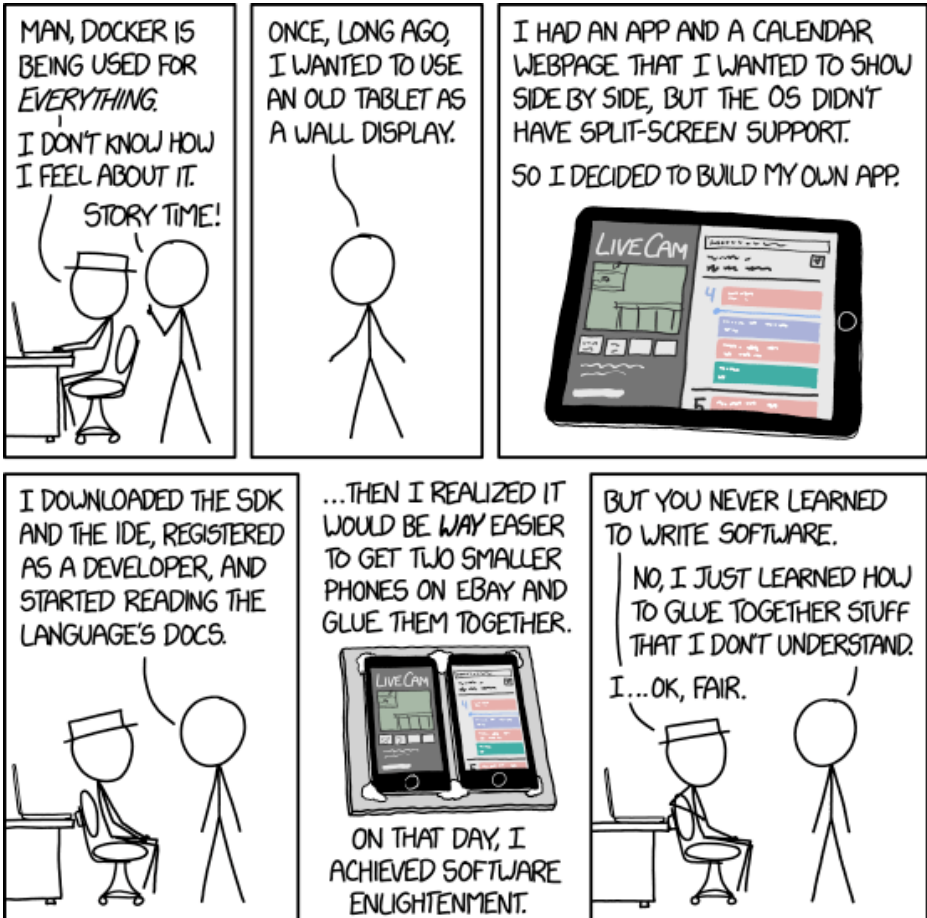
Superfund is a US federal government program created for cleaning up contaminated land. The comic is saying that his computer's Python environment is so messed up

that it's comparable to a real-world environmental disaster.

The title text may refer to the philosophical debate surrounding the construction of warning features around the WIPP site in New Mexico, and other nuclear waste disposal sites. In particular, it may refer to this article. These would have to last and be understandable for tens of thousands of years, longer than any known human-made structure or language to date. It also refers to the use of "sudo", a command utility included in many Linux distributions that allows a user to operate with heightened permissions. Using "sudo" to install a Python package may make the package available to the entire system, or, based on the settings of Virtualenv/Anaconda, it may end up installing the package in a user's home directory. This would make it so that the user could not update, edit, or remove the packages.

#1988: Containers

May 02, 2018



All services are microservices if you ignore most of their features.

Explanation

Docker is a computer program that performs operating-system-level virtualization also known as containerization. White Hat notices that many people are using Docker for "everything," implying that he does not understand what all the fuss is about. Cueball then explains the fundamental idea behind Docker with a simple story.

He notes how difficult it can be to combine two programs and have them work together as one. This is something all programmers can relate to. His specific example is to get two separate programs to display side-by-side on a tablet. The main joke is that Cueball's solution is a surprising twist to solving the problem. Instead of writing a lot of complicated code to deal with the problem at hand, he sidesteps the problem by using two separate devices, literally gluing them together. Containerization software, like Docker, uses the same general idea but the "glue" and the "multiple computers" are done in software, instead of literally gluing two computers together.

Cueball states that he achieved "software enlightenment" when he "solved" the problem by sidestepping it.

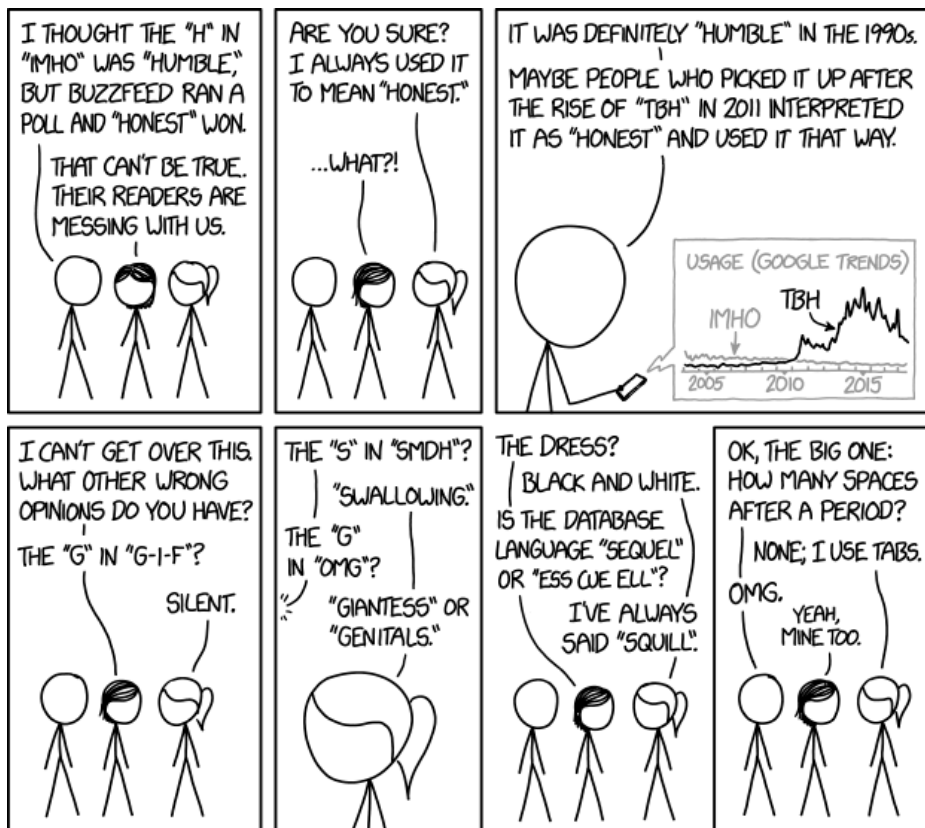
White Hat's initial confusion comes from the fact that Cueball did not write any software, yet achieved "software enlightenment." A good programmer doesn't necessarily need to be able to write programs or even

understand how they work, provided that they have the skills needed to combine existing programs to solve tasks. An alternate interpretation is that someone with little programming experience is able to create a working program simply by copy/pasting code snippets from a coding site such as Stack Overflow and "gluing" them together without really understanding how they work.

The title text makes a joke about developers writing code for use in a containerized environment. The ideal is to only write "microservices" which are modules that do just one thing and do it well. The joke here is that even when a module does many different things, you can pretend it is a "microservice" by just ignoring all of its features but one (hopefully one that it does well).

#1989: IMHO

May 04, 2018



"Ugh, TMI." "Yeah, that's some tantalizing meat info."

Explanation

The conversation begins with a reference to the controversy between whether IMHO stands for "in my honest opinion" or "in my humble opinion". Some older Internet users, including Cueball, use the H to mean "humble", which Cueball references as being the norm in the 1990s. However, many younger Internet users, including, apparently, Ponytail, use it to mean "honest", which became the norm after another SMS abbreviation, TBH (to be honest) became popular c. 2011. However, the joke veers into absurdity with Ponytail sharing her unusual opinions on other Internet controversies, including:

- Believing the G in GIF (Graphics Interchange Format) is silent, so she pronounces it "if", as opposed to the two main camps claiming it should be either a soft G (as in "giantess") or a hard G (as in "graphics"). Some people (okay, maybe just two) pronounce it as an "h" (like how Gs are pronounced in Spanish).
- Believing that the S in SMDH ("Shaking My Damn Head" or "So Much Damn Hate") stands for "swallowing".
- Believing that the G in OMG ("Oh My God" or "Oh My Goodness") stands for either "giantess" or "genitals."
- Believing a viral picture of a dress in very bad lighting is actually black and white. For context, the usual perceptions are black and blue to some people and white and gold to others (the manufacturer eventually

confirmed it to be black and blue). Though the dress may also appear blue and brown to some people, virtually no individual perceives the dress as black and white. The dress was previously mentioned in 1492: Dress Color.

- Believing that the database language SQL (Structured Query Language) is pronounced "squill" as opposed to the two main camps claiming it should be an acronym "sequel" (two syllables) or an initialism S-Q-L ("ess cue ell"; three syllables).
- Using tabs after periods, instead of the two main opposing camps of using either one or two spaces.

Before the 20th century, it was common typographical practice to use an em-space (or other similar wide-space) between sentences. In the 1930s, common practice was to use smaller inter-sentence spacing, and by the 1950s, inter-sentence spaces were the same size as inter-word spaces. Although modern style guides all insist on single-spacing between sentences, many people prefer to include two spaces, possibly out of habit from typewriter usage (which commonly used two spaces to mimic the 19th century typographic standards). (See also: 1285: Third Way.) Tabs vs. Spaces also refer to the programmers' debate on how to indent code correctly.

In the last panel, Cueball exclaims "OMG" (meaning "Oh, my God") to which Megan replies "Yeah, mine too", taking the meaning as "Oh, my genitals" from the 5th panel. This leads to the title text "TMI" (too much information). The pun on periods (typographical and

menstruation) might also explain the reaction.

In the title text, another incorrect belief Ponytail has is believing TMI to be "tantalizing meat info," as opposed to too much information. (Remarkably, this makes sense in the context of Megan's comment about her genitals.)

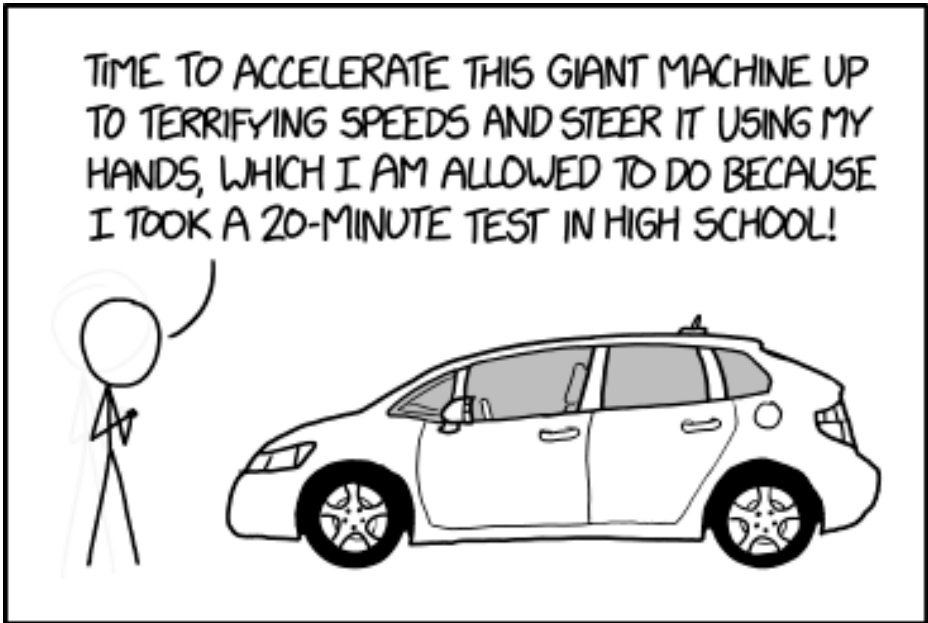
The comic also obliquely references the mistaken opinion that Website polling is an accurate measure of anything; selection bias (among many other problems) renders them almost useless for measuring the general population.

ESR's Jargon File (later known as The New Hacker's Dictionary) has an entry of "IMHO". It's also seen in variant forms such as IMNSHO (In My Not-So-Humble Opinion) and IMAO (In My Arrogant Opinion).

And it has been added into the Jargon File v2.1 in January 1990, the first version under Eric S. Raymond. Maybe the acronym "IMHO" was invented by science fiction fans in frequent discussions and used on the Usenet which started in 1980. It was in common usage as "humble" in APA (Amateur Press Association) publications during the 1980s, and possibly earlier.

#1990: Driving Cars

May 07, 2018



DRIVING FREAKS ME OUT.

It's probably just me. If driving were as dangerous as it seems, hundreds of people would be dying every day!

Explanation

This comic is about how dangerous cars are. Cueball observes that it is a giant machine, and that he is able to accelerate it up to terrifying speeds simply because he once took a brief driving test. Note that the length and complexity of a driving test varies greatly per country. 20 minutes would be fairly normal for the USA, but much shorter than what is required in most other Western countries. However, it should be noted that you sometimes have to retake the test if your drivers license has expired, so the "because I took a twenty minute test in high school" part is partially incorrect.

This is similar to other comics, such as 1075: Warning and 722: Computer Problems, where Randall comments on how some of our routine, everyday tasks are quite unusual when viewed from a reductionist perspective. This subject has been covered in the many comics about Self-driving cars. Although this comic is not directly about such cars, the reference to Cueball steering with his hands could be seen as being in contrast with letting a computer drive (which is much safer). The joke is that driving is in fact one of the top five most common causes of death, yet many (most?) people do not think of driving as an especially "scary" or "dangerous" activity.

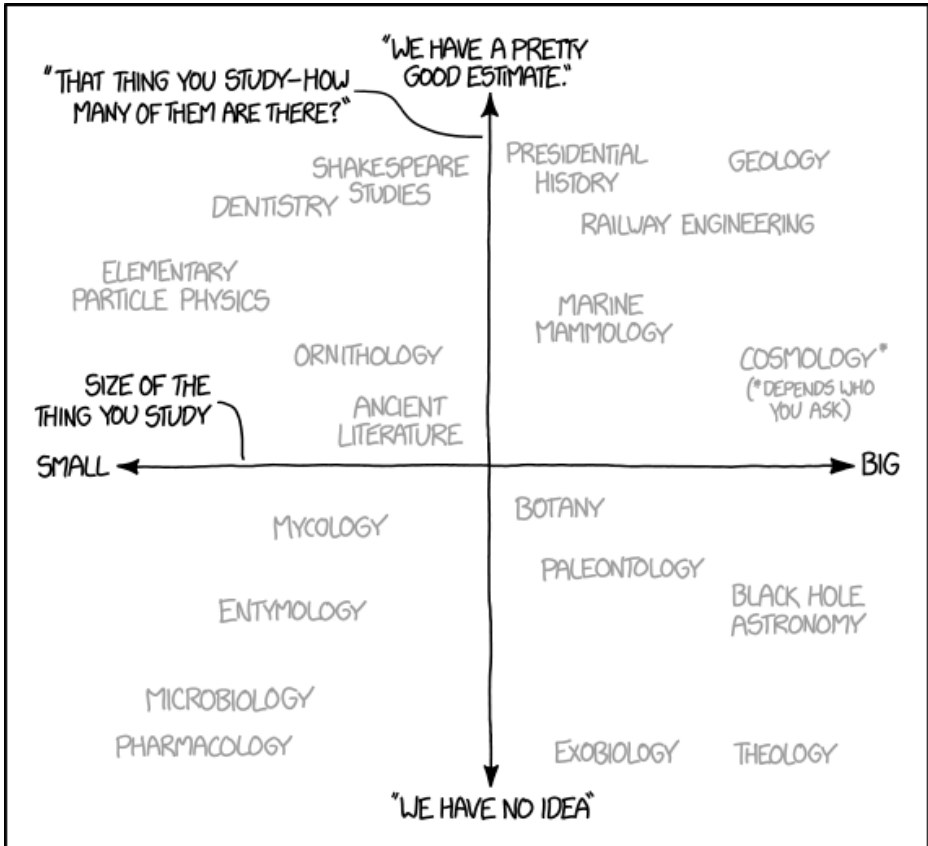
The rest of the joke is in the title text, "It's probably just me. If driving were as dangerous as it seems, hundreds of people would be dying every day!" This statement is ironic, drawing attention to the fact that many people

(over 3,000 per day world-wide, about 100 per day in the USA) do in fact die in car crashes. These statistics indicate that driving is as dangerous as Cueball thinks it seems; it is not just him perceiving it that way. As a matter of fact, in most regions of the US, automotive accidents are the leading cause of death for people aged 18 to 35. It's also worth noting that a difficult-to-estimate number of people die prematurely as a consequence of pollution caused by cars, but this isn't mentioned in the comic and pollution is not unique to automobiles.

In the background, behind Cueball, there is a low-contrast, sloppy drawing of Cueball. This is probably a mistake on Randall's part.

#1991: Research Areas by Size and Countedness

May 09, 2018



Mathematicians give a third answer on the vertical axis, "That question is poorly defined, but we have a sub-field devoted to every plausible version of it."

Explanation

This comic is a scatter plot that ranks different research fields according to the precision of the knowledge of the number of the studied object (vertical axis) vs. how large (the size of) the studied object is on the horizontal axis.

For instance, the facts pertaining to the number of United States presidents are well known (although the exact number can be disputed, in that Grover Cleveland's non-consecutive terms are usually counted separately, so the official count exceeds the number of individuals who have become President; Donald Trump repeating this feat), so the study of their history is at the top of the Y-axis. This study is placed close to the Y-axis as the size of a president is about midway in size between the two extremes of the X-axis, elementary particles to the left (small) and the entire cosmos (cosmology) to the right (big).

On the X-axis, Presidents are close to the middle. Both presidents and other larger life forms (as a research area) including extinct animals (paleontology) and exobiology are all close to the same central position just right of the Y-axis, with smaller animals like birds and insects just to the left of the Y-axis. But where the number of presidents is well known (aside from the handling of split-terms), then the number of exoplanet life forms (exobiology) is completely unknown (and would likely be affected by other disputes, such as whether something the size of Pluto counts as a planet) and thus it will be found at the

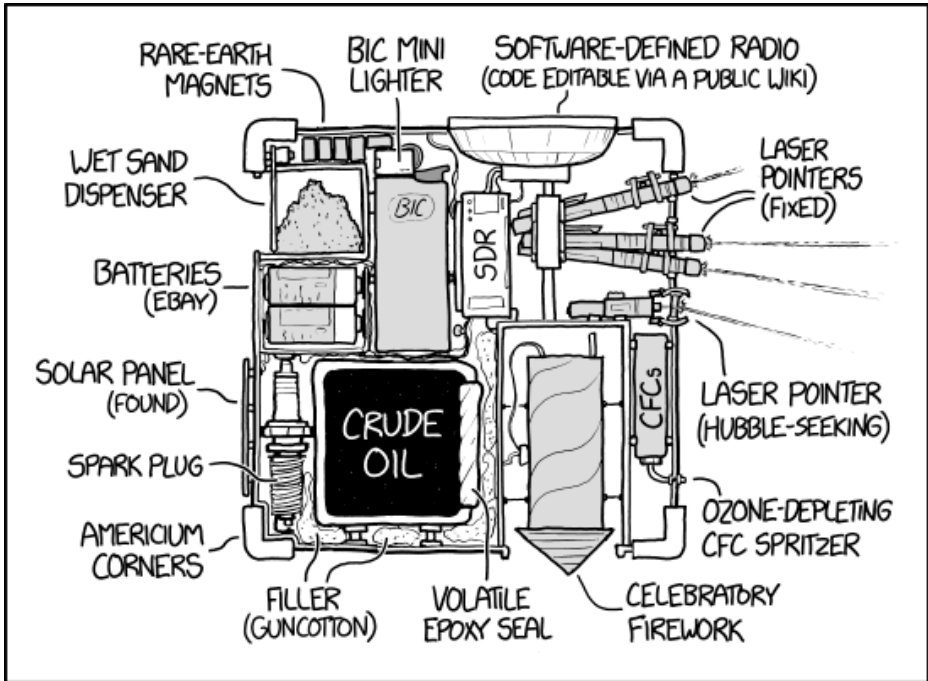
very bottom of the Y-axis, since we have no idea if there is life elsewhere and if so how many places will it be and how varied.

The 19 research areas are listed and explained in the tables below.

In the title text, mathematicians may give a third answer that the concept of counting the things being studied is not reasonable, because the things are abstract or otherwise not discrete. There are many different types of math that blend into each other, and many have turned into separate sub-disciplines based on different interpretations of fundamental rules. As a specific example in geometry, different interpretations of how many lines you may draw parallel to another line through a given point has lead to hyperbolic (infinite parallel lines) and spherical (0 parallel lines) geometric systems that are just as valid (and valuable, in some contexts) as the more commonly known Euclidean (1 parallel line) geometry. As a specific example of the blending, number theory, set theory, and topology all interrelate and it is difficult to concretely say whether many theorems belong to one branch of math or another.

#1992: SafetySat

May 11, 2018



MY CUBESAT PROPOSAL WAS THE FIRST TO BE REJECTED FOR VIOLATING EVERY DESIGN AND SAFETY REQUIREMENT SIMULTANEOUSLY.

During launch, in the event of an unexpected sensor reading, SafetySat will extend prongs in all directions to secure itself and any other cubesats safely in the launch vehicle until the source of the problem can be determined.

Explanation

CubeSat is a standard format for small satellites that can fit in a 10×10×10 cm format with a mass of less than 1.3 kg. They have been widely used by academics for research satellites, and by both small and large companies. CubeSats have been discussed both before and after this comic, in 1866: Russell's Teapot and 2148: Cubesat Launch.

CubeSats are often launched as an additional payload on commercial launches but also deployed from the International Space Station at the Kibo-Module or other airlocks. All these satellites are orbiting the Earth in a low orbit and since they have no propulsion system they also become a part of space debris when they are out of control; eventually they will reenter earth's atmosphere without any further hazard.

Only a few days before this comic was released the first interplanetary CubeSats called Mars Cube One was launched together with NASA's probe InSight (now offline) aiming to the planet Mars.

One of Randall's influences in creating this comic may have been controversy surrounding a commercial launch of a sub-CubeSat sized pico-satellite from a launch site in India, after the company had previously been denied launch permission within the US, due to safety concerns.

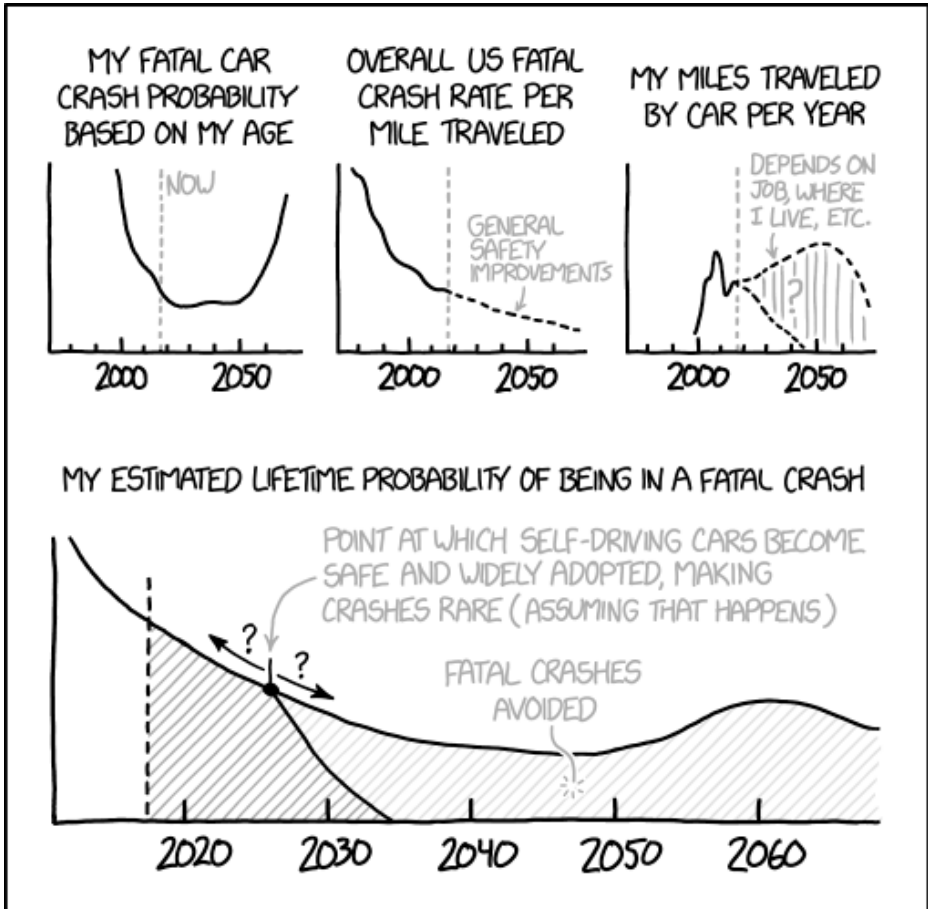
There are multiple safety rules to ensure that the

CubeSat cannot damage the primary payload. However, the joke in this comic is that Randall's design seeks to break as many rules as possible.

Items clockwise from top left:

#1993: Fatal Crash Rate

May 14, 2018



IT FEELS WEIRD TO LOOK AT CAR CRASH STATISTICS AND WONDER WHETHER WE'LL ALL BE ABLE TO STOP DRIVING BEFORE I'M INVOLVED IN A FATAL CRASH.

Fixating on this seems unhealthy. But in general, the more likely I think a crash is, the less likely one becomes, which is a strange kind of reverse placebo effect.

Explanation

This is the second recent comic after 1990: Driving Cars on the subject of the dangers of cars.

It combines general statistical correlations between age and safety improvements with fatal crashes. The graphs are:

- Fatal car crash probability based on age: Young drivers are generally considered more reckless, which leads to more accidents (Randall is shown to have started this stage in the year 2000). Actuaries noted a spike in the death rates for teenage boys even before cars were invented. As drivers become comfortable with driving, internalizing the rules of the road, their accident probability quickly drops, but this decrease becomes less pronounced when the driver needs to adapt to new traffic patterns due to moving or changing schedules (2010). After driving for 20 years, accident probability reaches a minimum, but is shown to rise slightly in 2040, probably because Randall fears a midlife crisis. By 2050, aging starts to affect a driver's abilities (reflexes, concentration, eyesight, etc) so accident probability rises. The graph seems to be based fairly accurately on Massie and Cambell's 1993 paper 'analysis of Accident Rates by Age, Gender and time of Day ...' itself taken from a 1990 survey. At the time the overall rate was 3.03 fatalities per 100 million vehicle miles - with rates of 9.21 for teenagers and 11.53 for those over 75. At the time those over 75 (born 1915 or earlier) may well not

have been formally taught to drive. It would be interesting to see how this data changes with time.

- Overall US fatal crash rate per mile traveled: This graph attempts to normalize these factors by correlating accident probability to how many miles the driver had driven by the time they died in an accident. However, the accident probability decreases with time as road traffic safety improves. The graph does a conservative estimate for future years, probably because improvements are, by nature, incremental -- which is why the graph has a slightly hyperbolic shape.
- My miles traveled by car per year provides an estimate of miles traveled to be able to apply the second graph to himself. It shows a rise in the later half of the 2000s decade (indicating a job which requires a lot of driving) and a fall shortly after (indicating a job that doesn't require much driving). with a rise up to the present. The graph predicts either that this rise will continue, or will drop since this "depends on job, where I live etc."

The final graph, ostensibly the product of the three previous graphs' probabilities, shows that Randall worries that he will eventually be involved in a fatal car crash unless self driving cars take over, which he believes would eliminate car related fatalities. He is of the opinion that they will take over, but that they might not do so quickly enough to 'save' him from the spike of age-related fatalities in later life.

The comic includes three smaller line graphs along the top, and then a larger line graph, which is kind of a

combination of the three smaller ones, at the bottom. A vertical dotted line is used on all these graphs to indicate "now", 2018; everything to the left of the graph has already happened (though the graphs are showing statistical history rather than actual history) and everything to the right is projected to happen, statistically.

The first smaller graph, labeled "My fatal car crash probability based on my age", shows the likelihood he'll be involved in a car crash at different ages. The line doesn't start until slightly before 2000, probably when he first learned how to drive and started driving himself. He's not including when he would have been a child and a passenger, just when he is the actual driver. The two most dangerous ages to be driving are generally when you've first learned how to drive (and haven't yet mastered the skills or gained learned reflexes) and then again at an elderly age when your reflexes are slower and your senses become more limited (narrow field of vision/loss of peripheral vision, worse hearing, etc.).

The middle smaller graph, labeled "Overall US fatal crash rate per mile traveled", lists how likely a fatal car crash is on a mile-by-mile basis, regardless of age. It used to be you were much more likely to have a fatal car crash in any given mile due to lack of safety features in cars in the 1970's. As more safety features were introduced and mandated, some to help prevent accidents (i.e. anti-lock brakes) and some to help make more of the accidents survivable (seat belts, air bags), overall safety has improved and is projected to continue improving.

The third smaller graph, labeled "My miles traveled by car each year", is a simple graph of the distance Randall has driven every year. As he approached 2010, he was driving a lot more than when he first started, then life circumstances presumably changed so his need to drive diminished a bit, and now it's slightly increasing again. He has no way to predict future life driving needs, however, so the graph converges after "now" to include both gradually increasing as well as gradually decreasing driving needs. At an advanced age he'll probably mostly stop driving.

The final, large graph, labeled "My estimated lifetime probability of being in a fatal car crash", combines these different factors into a smoother curve of gradually being safer (or at least not dying) while driving, with the possibility introduced, at an indeterminate time, that self-driving cars get to the point where they are both safe and widely adopted, at which point Randall expects the chance of a fatality to decrease to zero over a relatively short period of time (i.e. a decade). In the event the self-driving cars do not deliver in safely and/or are not widely adopted, the safety will gradually level off and then increase a bit near older age before dropping off again, but always with a distinct chance of fatality.

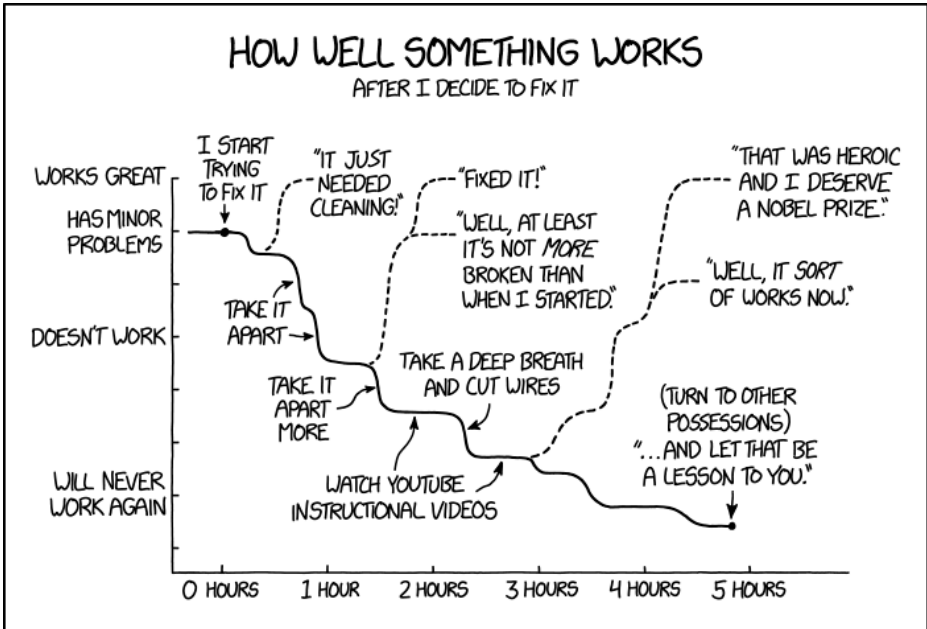
As the title text points out, fixating to this degree on a single source of danger is unhealthy. But the more Randall fixates on the danger of car crashes, the safer (or maybe the less) he drives, which reduces his chance of being in a fatal car crash.

Note that Randall used to fixate on the danger of velociraptors, there is even an entire category based on his fear of them.

If one were to become a professional driver and drive at 50 mph for 8 hours a day, 200 days a year, for 50 years - one would drive about 4 million miles - so one's risk of dying in a car crash would be much less than 1%.

#1994: Repairs

May 16, 2018



I was just disassembling it over the course of five hours so it would fit in the trash more efficiently.

Explanation

This graph depicts the sentiment created by the act of repairing something, depending on the time it took (x-axis) and the ensuing result (y-axis). The degree of triumph and exultation (expressed in sentences in quotes inside the graph) is strongly enhanced by the time the operation takes and is also positively correlated with the result (if any). Actions during the repair process are described in sentences without quotes.

The conclusions are rather optimistic; the most negative feeling expressed (after the maximum time of repair with the minimum degree of success) is a threat against other objects that might have plans to break.

The graph shows the main path most of his fixes apparently usually take (solid line) along with some variations they sometimes take (dotted lines). Projects usually start out with items that mostly work, but have minor problems. Occasionally they just need a cleaning (first dotted line). If that doesn't work, he takes them partly apart, and then there are times he's able to put them back together and get them to either work completely (one branch of a dotted line) or get it back to the condition it started out in (the other branch of the dotted line), at which point he doesn't tempt fate by continuing, knowing what's likely to happen if he continues messing with it. When it's still not working, he takes it apart more, starts doing less reversible things like cutting wires, and finally starts watching YouTube

videos hopefully showing the right way to fix it, or at least how others fixed it. This takes it to a state just one step above "Will never work again", after which there can be several results. One dotted line shows it's restored to being fully fixed and he feels victorious and proud that all the hard work paid off, and he thinks he deserves a Nobel Prize for his efforts. The next dotted line is when he gets it partially working again, and gives up, satisfied to at least not have completely destroyed it even though it's a little worse than before. The third, main path result is total failure, which he could take as a personal failure but to which he instead responds with humor by admonishing the rest of his possessions not to develop minor problems otherwise the same total destruction might happen to them. This path ends up a partial step below "Will never work again" so it's unclear what that state is... maybe that's the "throw it away" state.

The title text shows another excuse for failure. Nobody would spend five hours being a trash compactor. One could however claim to be separating the different parts for sorting into recycling bins or separating the parts that aren't themselves damaged by the process from those that will no longer be of use to anyone. This still doesn't have any tangible benefits for the one doing the sorting (although it might earn them points with the recipient).

A similar sentiment was expressed in 349: Success. However, in Success, the computer would keep developing new problems and putting Cueball in worse and worse situations while in this comic it is just that Randall has increasing trouble fixing the issue as time

wears on.

#1995: MC Hammer Age

May 18, 2018



MY HOBBY: DELIBERATELY LOWBALLING
"WANT TO FEEL OLD" FACTOIDS TO SET
UP A BIGGER PAYOFF LATER WHEN
THEY LEARN THE CORRECT NUMBER.

Wait, sorry, I got mixed up--he's actually almost 50. It's the kid from The Karate Kid who just turned 40.

Explanation

This is the first comic to combine the My Hobby series with the theme of listing facts that make one feel old.

In the comic Cueball (as Randall, as it is his hobby) is asking White Hat if he wants to feel old. (This exact opening phrase was used by Megan in 1898: October 2017). Cueball doesn't wait for an answer, though like Megan did, but tells White Hat that MC Hammer just turned 40. Surprisingly, at first, this doesn't really make White Hat feel old, he actually feels this is rather normal (compared to his own age). MC Hammer is a pop rapper/singer who was most popular in the early 1990's for U Can't Touch This with the catch phrase Stop: Hammer Time, and shiny baggy pants often incorrectly referred to as parachute pants.

So at first it seems that Randall's attempt to make White Hat feel old has failed miserably. However in the caption Randall explains that this is part of his hobby. By "lowballing" the facts to begin with he can make people feel really old when he tells them the truth, so they learn that the correct number (age/years ago, your age at the time etc.) is even worse than the first opening statement.

In the title text he then tells White Hat the "truth": "Wait, sorry, I got mixed up--he's actually almost 50. It's the kid from The Karate Kid who just turned 40." This suddenly adds ten more years to MC Hammer's age, and the kid from the Karate Kid movies is already 40 years

old. This likely makes White Hat feel old. In the original *The Karate Kid*, Ralph Macchio was the actor who starred as Karate Kid.

The real blow, comes when White Hat (and most likely the reader), now intrigued goes home and looks these two people up on Wikipedia. Ralph Macchio was already much older than the kid he portrays in the movie, a school kid - he was 22 years old when shooting the first movie. On the day this comic came out, both MC Hammer and Ralph Macchio were 56 years old. And Ralph is the older one of the two being born in 1961, while Hammer was born in 1962. (In fact, Macchio is older now than Pat Morita, who played his mentor in *The Karate Kid*, was when that film was released.)

So even in the title text, the corrections are both "lowballed" facts, so still preserving the maximum effect while adding more credibility to the claims, so people already start to feel old before the last 6 years is added to Hammer's age.

Of course, this is assuming they do look it up, and if they believe Randall the first time, there is no reason to assume this will happen. However, then they probably already feel old from the first correction.

Note that in the other make one feel old comics Randall did not apparently indulge in this new hobby of lowballing facts. As far as we can tell, those were all accurate for the time the comic was created. But if this is a new hobby, we may need to examine newer "feel old"

comics extra carefully from now on. (If we want to feel even older that is.)

#1996: Morning News

May 21, 2018



Support your local paper, unless it's just been bought by some sinister hedge fund or something, which it probably has.

Explanation

Megan is complaining to Hairbun about her easy access to infuriating national news stories and bad opinions (editorial articles and commentary) and worries that it may be having a negative effect on her, perhaps by promoting misinformation, by distraction, or by prompting adverse emotional reaction to content; she muses that, in some way or another, this habit is probably doing some sort of damage to her brain's wiring, training it to think in ways that are not necessarily good. While the capacity of the brain to change and adapt to a person's daily habits is, like most neurological phenomena, as yet not very well understood, it's clear that something of the sort exists--scientists refer to this capacity as "neuroplasticity."

Hairbun sarcastically tells Megan that things were different in her time, implicitly stating that access to infuriating stories via newspapers took only a tiny bit more time and effort during a morning routine compared to accessing them via the Internet.

Megan counters this idea and says that while it is true that newspapers provided the sort of national news she is being provoked by, they also had much more local news mixed in (which may be of a lighter nature, sometimes referred to in a derogatory sense as "fluff" news pieces), to which Hairbun agrees.

Megan also raises the point that bad opinions were not

granted wide distribution. Hairbun is rather less quick to agree to this, and suggests that Megan not check that, revealing that Megan's assertion isn't entirely true. Indeed, before the Internet, newspapers were a common medium for expressing opinions, either by local columnists or average citizens via letters to the editor, and they, as with any body of opinions throughout history, were frequently noxious or ill-informed.

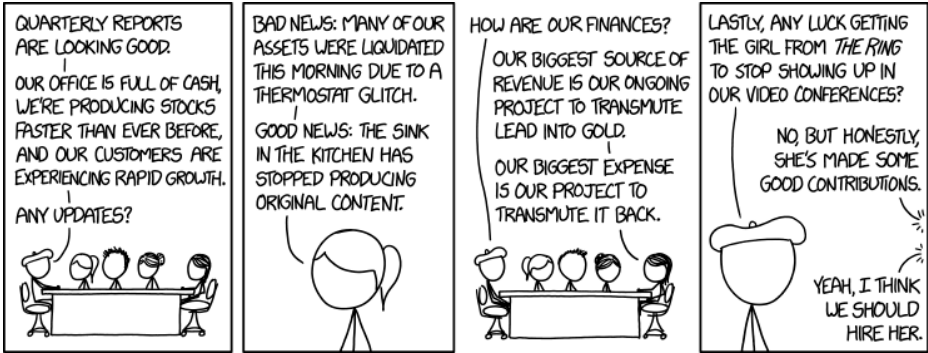
This comic has a similar tone to 1348: Before the Internet in that it makes fun of the idea that life and society were better "in the good old days".

The title text takes another jab at newspapers as a supposedly superior source of news. Supporting your local paper is generally considered a positive action, as it is often the best or only source for local news (national media can't focus on smaller areas, and radio/television often lacks print media's focus on investigative journalism). However, in recent years, many seemingly independent local newspapers in major cities have been bought up by financial groups rather than traditional publishing companies, and their effect on the industry as a whole has been controversial. Most notably, hedge fund groups often attempt to make newspapers profitable by cutting costs and downsizing, at the expense of quality reporting; critics call such hedge fund groups "vulture capitalists" who are throttling newspapers for short-term profit, without any thought of long-term viability or public service. The owners of the fund may also be unethical or controversial for other reasons. Thus, the standard well-meaning suggestion of

supporting your local paper may no longer be good advice.

#1997: Business Update

May 23, 2018



Our customers keep sending us their personal information, even though we've repeatedly asked them to stop. The EU told me I'm the heir to some ancient European throne that makes me exempt from the GDPR, but we should probably still try to fix that.

Explanation

This comic shows a meeting at Beret Guy's business (as seen in these other comics). As usual, those in the business demonstrate a misuse of business terminology and take strange happenings within the business in their stride.

Though maintaining a semblance of business-savviness through the use of many corporate buzzwords, it becomes clear that what is normally metaphorical in a usual boardroom meeting is here quite likely meant literally. The Quarterly Reports, described as "looking good," may be literally aesthetically pleasing (rather than recording successful business dealings). Beret Guy's comment that "the office is full of cash" seems to be an ordinary comment at a glance, but him saying that the office contains a lot of money instead of has a lot of money implies that the office is literally full of money, such as coins, dollar bills, twenty-dollar bills, etc., and not simply economically well-off. Most businesses keep their money in banks; any business that keeps all their money insecurely in the office is either criminally shady or incompetent.

"We're producing stocks [as in the stock market, a.k.a. shares] faster than ever before." Stocks are valuable, so from an outside perspective making more of them would create value. However, the humor of this situation is that in real life, creating shares from nothing would reduce the value of existing shares (as the combined value of

stocks should add up to the total value of the company...so creating more stocks means each has to be worth less to make the addition balance out). This is ironic in that typically stocks represent the value of the company, rather than being the product being created.

Alternatively, the company may be producing the leg restraints known as stocks. It's unlikely that there would be many people wishing to buy these stocks. Conversely, if what they are making is soup stocks, then it could be related to the 'rapid growth' (i.e., obesity) of the customers.

"Rapid growth" is something a business is supposed to attain for itself or its userbase, not its individual customers. If the customers are not children they are likely very concerned by this rapid growth, as should be Beret Guy if the rapid growth is being caused by his business and its products.

"Liquidating assets" typically means that assets are being sold off for money rather than being retained or used. Assets "liquidated" in a thermostat glitch, meanwhile, may have been literally melted ("turned into liquid"). It could also mean that their infrastructure is so hilariously messed up (and/or the assets so bizarre) that a simple glitch in a thermostat somehow resulted in the loss of a large amount of the company's assets. Note that this type of thing is not entirely unheard of, as shown by a hack of a thermostat in a casino that led to massive data loss in 2017.

"Original content" is a catch-all term for unique creative products created by a website, e.g. articles, videos or TV shows. However, it is not typically used to describe sinks, which only provide water. Since the business team regards it as a problem, this means the sink is likely leaking or backing up, possibly with polluted water or rotting food waste, or perhaps creating things one would not expect a sink to dispense or even to exist (depending on how "original" this original content is). When interpreted more literally, perhaps the sink is somehow thinking up new ideas (evidently not very good ones, if their end is apparently "good news") and suggesting them to the customers or employees.

Transmuting lead into gold was a goal of alchemists for many centuries. With modern nuclear technology, it is actually now possible to accomplish transmutation of lead into gold, and gold into lead. While the expense far exceeds the value of the gold produced by such methods, it seems plausible that, given Beret Guy's surpassing strangeness, his company may be successfully and cheaply transmuting large quantities of lead into gold and back again. Since gold is worth much more than lead in today's market, the first transmutation could indeed result in major profit, while the reverse would obviously result in major losses, and be a rather pointless undertaking for a typical, profit-oriented business.

It is also worth noting that the "largest source of revenue" may not be producing much revenue at all; it can still be the biggest if there are no others. On the other hand, past experience with Beret Guy's business would indicate that

this company is making plenty of money, though they aren't necessarily sure how.

Alternately, Beret Guy may be speaking literally about their "biggest source of revenue," referring not to the amount of revenue generated, but to the physical size of the source itself. A facility capable of transmuting heavy elements would most likely be constructed around a large particle accelerator such as a synchrotron, and accelerators of this type commonly measure several kilometers in diameter. Such a facility would likely be the largest physical structure owned by a commercial entity.

In the last panel, "the girl from The Ring" refers to Sadako Yamamura, the antagonist of the Ring series by Koji Suzuki, or her counterpart Samara Morgan from the American remake, who has been referenced by xkcd several times in the past — 396: The Ring for example. One of Sadako/Samara's supernatural abilities is to appear in television screens as well as exit from them into the real world. Beret Guy claims she has done this several times in their video conferences, which may be possible if someone has hacked their video feed to play footage from the 2002 movie. However, some of Beret Guy's employees then proceed to remark that she has made contributions to the meetings in question, implying that the image of Sadako/Samara is not only alive but sentient and communicating with the employees, rather than killing them as she typically does in her movies. It's also possible that Sadako/Samara is simply the recording from the series, and her contributions are just in keeping with the general tone of the company's video

conferences. Either way, it would appear that Beret Guy's sheer eccentricity has affected his staff to the point that a digital spectre would not be an abnormal employee; they're also oddly nonchalant about a movie character appearing in the real world, and at Sadako/Samara's out-of-character behavior.

The title text refers to the May 25 deadline to implement the European Union's General Data Protection Regulation (GDPR); this comic parodies a business meeting about what the company is doing to prepare for it. However, while normally the problem would be how to handle the customers' personal information that the company requires to retain in order to do business, in this case it seems the company does not require personal information at all, and instead, customers are sending them theirs on their own (and they refuse to stop doing it!). Even more bizarrely, Beret Guy was told by the EU (or at least, he thinks he was) that he is exempt because he is European royalty of some kind, which would give him sovereign immunity, but he wants to fix this problem anyway, just to be on the safe side. The next comic also is directly about the GDPR.

#1998: GDPR

May 25, 2018

PRIVACY POLICY

WE'VE UPDATED OUR PRIVACY POLICY. THIS IS PURELY OUT OF THE GOODNESS OF OUR HEARTS, AND HAS NOTHING TO DO WITH ANY HYPOTHETICAL UNIONS ON ANY PARTICULAR CONTINENTS. PLEASE READ EVERY PART OF THIS POLICY CAREFULLY, AND DON'T JUST SKIP AHEAD LOOKING FOR SEX SCENES.

THIS POLICY GOVERNS YOUR INTERACTIONS WITH THIS WEBSITE, HEREIN REFERRED TO AS "THE SERVICE," "THE WEBSITE," "THE INTERNET," OR "FACEBOOK," AND WITH ALL OTHER WEBSITES AND ORGANIZATIONS OF ANY KIND. THE ENUMERATION IN THIS POLICY, OF CERTAIN RIGHTS, SHALL NOT BE CONSTRUED TO DENY OR DISPARAGE OTHERS RETAINED BY THE USERS. BY USING THIS SERVICE, YOU OPT IN TO QUARTERING TROOPS IN YOUR HOME.

YOUR PERSONAL INFORMATION

PLEASE DON'T SEND US YOUR PERSONAL INFORMATION. WE DO NOT WANT YOUR PERSONAL INFORMATION. WE HAVE A HARD ENOUGH TIME KEEPING TRACK OF OUR OWN PERSONAL INFORMATION, LET ALONE YOURS.

IF YOU TELL US YOUR NAME, OR ANY IDENTIFYING INFORMATION, WE WILL FORGET IT IMMEDIATELY. THE NEXT TIME WE SEE YOU, WE'LL STRUGGLE TO REMEMBER WHO YOU ARE, AND TRY DESPERATELY TO GET THROUGH THE CONVERSATION SO WE CAN GO ONLINE AND HOPEFULLY FIGURE IT OUT.

TRACKING PIXELS, COOKIES, AND BEACONS

THIS WEBSITE PLACES PIXELS ON YOUR SCREEN IN ORDER TO FORM TEXT AND IMAGES, SOME OF WHICH MAY REMAIN IN YOUR MEMORY AFTER YOU CLOSE THE PAGE. WE USE COOKIES TO ENHANCE YOUR PERFORMANCE. OUR WEBSITE MAY USE LOCAL STORAGE ON YOUR DEVICE IF WE RUN LOW ON SPACE ON OUR END. WE MAY USE BEACONS TO CALL ROHAN FOR AID.

3RD PARTY EXTENSIONS

THIS SERVICE MAY UTILIZE 3RD PARTY EXTENSIONS IN ORDER TO PLAY THE SONG *CAN U FEEL IT* FROM THEIR DEBUT ALBUM *ALIVE*.

PERMISSION

FOR USERS WHO ARE CITIZENS OF THE EUROPEAN UNION, WE WILL NOW BE REQUESTING PERMISSION BEFORE INITIATING ORGAN HARVESTING.

SCOPE AND LIMITATIONS

THIS POLICY SUPERSEDES ANY APPLICABLE FEDERAL, STATE, AND LOCAL LAWS, REGULATIONS AND ORDINANCES, INTERNATIONAL TREATIES, AND LEGAL AGREEMENTS THAT WOULD OTHERWISE APPLY. IF ANY PROVISION OF THIS POLICY IS FOUND BY A COURT TO BE UNENFORCEABLE, IT NEVERTHELESS REMAINS IN FORCE.

THIS ORGANIZATION IS NOT LIABLE AND THIS AGREEMENT SHALL NOT BE CONSTRUED. THESE STATEMENTS HAVE NOT BEEN EVALUATED BY THE FDA. THIS WEBSITE IS INTENDED TO TREAT, CURE, AND PREVENT ANY DISEASE.

IF YOU KNOW ANYONE IN EUROPE, PLEASE TELL THEM WE'RE COOL.

By clicking anywhere, scrolling, or closing this notification, you agree to be legally bound by the witch Sycorax within a cloven pine.

Explanation

This comic was released on the date on which the General Data Protection Regulation (GDPR) law went into effect. Most people will have already seen a large number of updated privacy policies in the week or two leading up to this law going active. And while xkcd would likely be outside of the jurisdiction that the law can enforce, it technically does fall within the scope of the law (as certainly EU citizens visit xkcd). This extra-territorial applicability is one of the major keys in this regulation and can be seen in more detail at the EU GDPR Information Portal.

There are several references made to this law, but also several jokes are included about the way people treat privacy policies specifically, and user agreements in general.

The comic is a joke privacy policy, with terms that no one would agree to under normal circumstances. In most cases, website users will use websites without reading the policies, potentially "agreeing" to something unexpected.

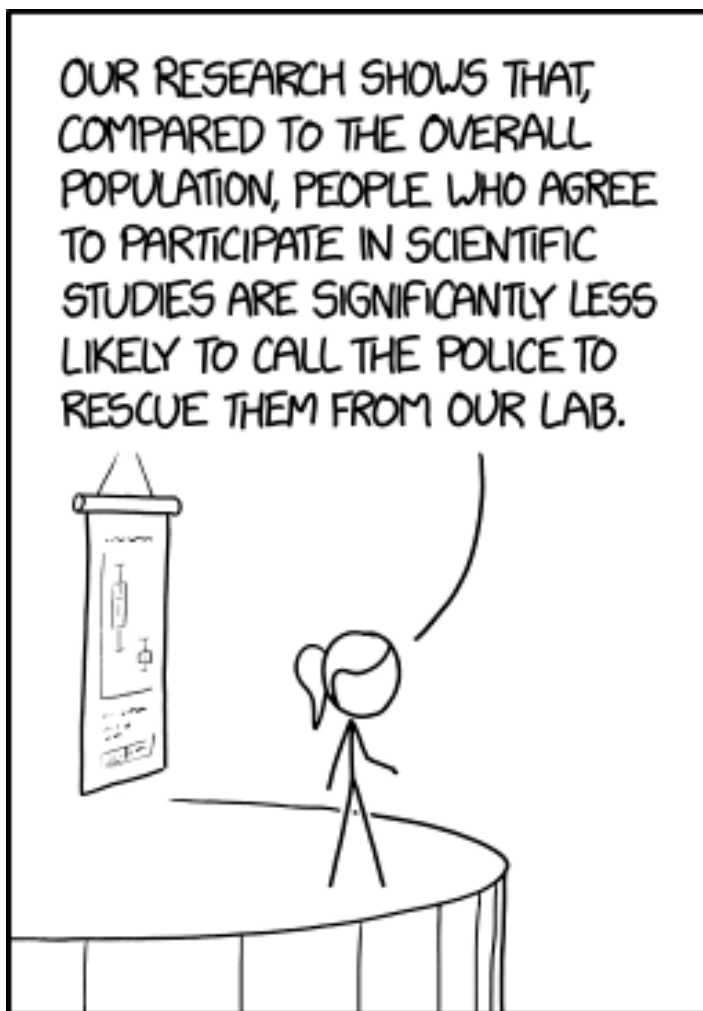
The title text is a reference to Shakespeare's "The Tempest", in which the witch Sycorax imprisoned the sprite Ariel in a cloven pine prior to Ariel's rescue by Prospero. As this clause cannot be escaped by anything short of restarting your computer, it may also reflect on how hard it often proves to be to opt out of privacy policy agreements and other forms to be filled on

website, for all that they may appear optional. The fact that it appears as a title-text akin to a footnote, which a careless reader of the Privacy Policy may not notice at first glance, may also continue the joke of small but unexpected clauses hidden amidst a long-winded block of legalese, agreed to by users who haven't read them.

A prior contractual agreement involved such a diabolical agreement being twisted in the opposite direction.

#1999: Selection Effect

May 28, 2018



fMRI testing showed that subjects who don't agree to participate are much more likely to escape from the machine mid-scan.

Explanation

The title refers to the effect in scientific fields where instead of investigating the whole population (i.e. all cancer patients or all trees) only a subset is analysed. This is common practice as the analysis of all specimens is often impractical. However, special care needs to be taken when selecting the sample to ensure that it accurately represents the general population. Otherwise the results are misleading and do not reflect reality. For example if 1000 people are asked about the numbers of cars they own but all live in a city the results cannot be generalised to the whole country. This is called the selection bias. If non-human subjects are studied this can be avoided by randomising the selection process, but this is not possible with humans as they cannot be forced to participate in a study against their will. For example, if people are asked to participate in a study about their political views it is likely that the responders care about politics while people with no clear opinion do not bother to respond. This is called the self-selection bias.

Ponytail says that people who agree to be in a study at their lab are less likely to attempt to escape. The only way Ponytail could have come to this conclusion is if she compared those people to people who did not agree to be in the study. This implies that Ponytail has recently kidnapped people for a study, and that most of the people she kidnapped called the police, as one should do when being kidnapped. This makes sense, since if you agreed to the study, you know why you are there, while if

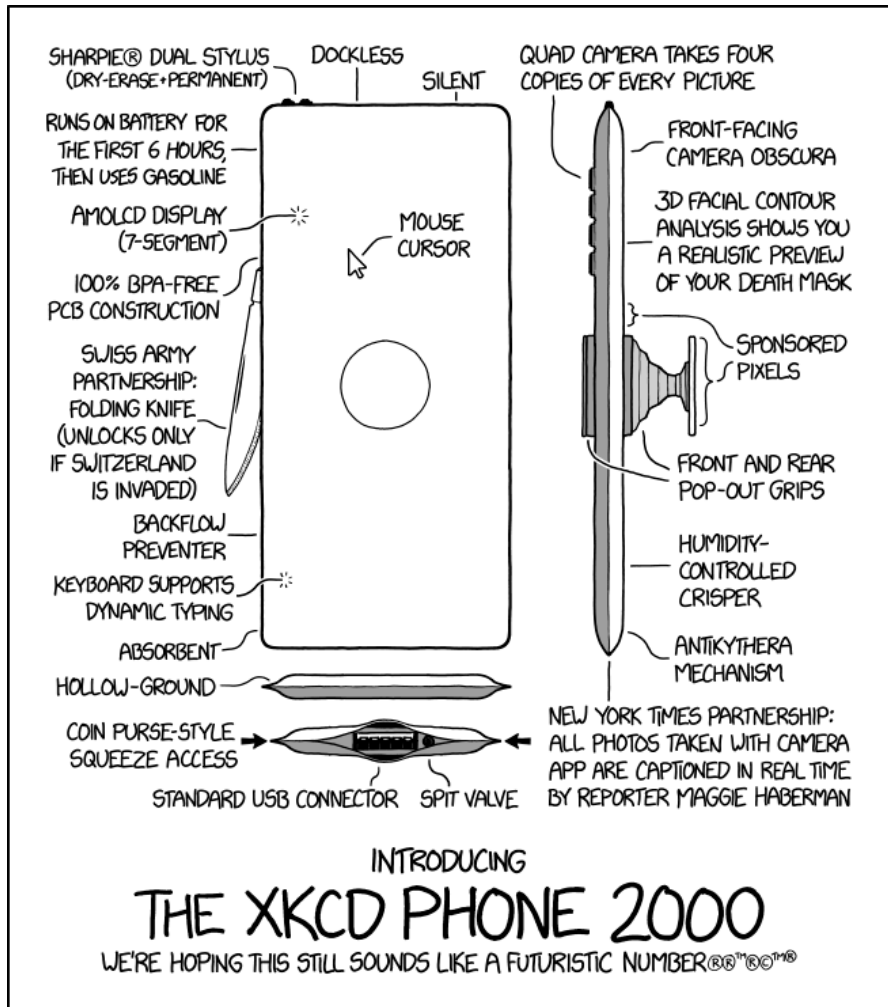
you didn't, you may have been kidnapped. As Ponytail presents this as a finding, it appears that she was attempting to establish a protocol for randomised selection of human subjects and comparing it to the normal selection process.

The comic shows Ponytail being allowed to present the results of this study at a conference; reputable scientific journals and conferences should not legitimize studies that clearly violate their ethical norms, such as by failing to obtain informed consent from human subjects before experimenting on them. Unfortunately, involuntary studies are published and presented, like this 2014 Facebook's emotional contagion study. It is not clear how many people who did agree to participate may have attempted to call the police for assistance regardless; compare the Stanford Prison Experiment. This is similar to previous comics where obvious things are presented in obfuscated, scientific ways (e.g. 1990: Driving Cars). Of course, any study of the way people behave when being kidnapped for scientific experiments would inherently involve kidnapping them. Therefore there is no way this kind of research could be done in an ethical fashion.

The title text refers to a technique that measures brain activity, called Functional magnetic resonance imaging (fMRI). Of course it's much more likely that people who did not sign up will resist and escape before the scan is complete. This technique has been mentioned before, such as in 1453: fMRI and 1526: Placebo Blocker

#2000: xkcd Phone 2000

May 30, 2018



Our retina display features hundreds of pixels per inch in the central fovea region.

Explanation

This is the seventh entry in the ongoing xkcd Phone series, and once again, the comic plays with many standard tech buzzwords, and horribly misuses all of them, to create a phone that sounds impressive but self-evidently isn't to even the most ignorant customer. The previous comic in the series 1889: xkcd Phone 6 was released 8 and a half months before this one, and the next comic 2377: xkcd Phone 12 was released two years and five months later.

This time, a nonconsecutive version number is used to match the 2000th xkcd comic number. The tagline for the phone says that the marketing team hopes that 2000 still sounds like a futuristic number. It was common for a time to have futuristic science-fiction take place on or around the year 2000 (e.g. 2001: A Space Odyssey, Knight Rider 2000, Death Race 2000, Space: 1999), and many devices marketed in the late 20th century had a "2000" as part of their product name in order to sound futuristic. However, since the year 2000 is decades ago, this is no longer the case. The number 2000 also represents the fact that this is the 2000th xkcd comic. The nonsensical trademarking of xkcd Phone slogans has become even more pronounced: as well as the inapplicable-as-ever copyright symbol, the slogan is listed three times as a registered trademark and twice as an unregistered one – and the second of those trademark signs is itself trademarked.

From the top, going clockwise:

The title text refers to Retina Display, a term used to describe Apple products with higher pixel densities. The xkcd Phone marketing team would be unable to use the term due to Apple's having registered it as a trademark, as it would likely be trademark infringement. Additionally, the central fovea region is a portion of your eye's retina containing the most densely packed photosensitive neurons (confusing the biological retina with the electronics display of the same name). Foveated rendering is a genuine computer graphics technique intended to increase performance by rendering with higher quality to the regions of the display where the user is looking, and lower quality at the edges of vision; it is expected to be useful for virtual reality (one of the uses for cell phones) as a way to deal with the required high pixel densities while managing power consumption. There are displays with variable density, in specialist uses, but such a feature is not practical in a phone because the whole area of the display is typically useful and needs to provide high resolution (as the user's eye moves across it). Also, hundreds of pixels per inch is not considered a very high resolution, as a full-HD smartphone has 440.58 pixels per inch.

#2001: Clickbait-Corrected p-Value

June 01, 2018

CLICKBAIT-CORRECTED P-VALUE:

$$P_{CL} = P_{\text{TRADITIONAL}} \cdot \frac{\text{CLICK}(H_1)}{\text{CLICK}(H_0)}$$

NULL HYPOTHESIS

H_0 : ("CHOCOLATE HAS NO EFFECT
ON ATHLETIC PERFORMANCE")

ALTERNATIVE HYPOTHESIS

H_1 : ("CHOCOLATE BOOSTS
ATHLETIC PERFORMANCE")

FRACTION OF TEST SUBJECTS

$\text{CLICK}(H)$: WHO CLICK ON A HEADLINE
ANNOUNCING THAT H IS TRUE

When comparing hypotheses with Bayesian methods, the similar 'clickbayes factor' can account for some harder-to-quantify priors.

Explanation

Clickbait is the practice of using deceptive or hyperbolic headlines to entice readers to click on a dubious or sensationalist news story, often with the purpose of generating site traffic and ad revenue. Randall uses the scientific controversy regarding the health effects of chocolate to humans as an example, as there is widespread misinformation on the health effects of chocolate online. In fact, there are no reliable studies to confirm any health effects while no medical authority has approved any health claims regarding chocolate.

Hypothesis testing in statistics is a standard method to determine whether a particular hypothesis is supported by the data. For the topic given in this comic, a researcher might compare data on athletic performance with data on chocolate consumption by those athletes to determine whether the two trend together. By convention, the "null hypothesis" (denoted H_0) is that there is no correlation (e.g. chocolate doesn't affect athletic performance) while the "alternate hypothesis" (H_1) would be that they are correlated. (If the study consists of feeding chocolate to one of two identical groups and not the other, rather than tracking what they'd be eating anyway, then the alternative hypothesis can be strengthened to be that chocolate causes improved performance.) These sets are subjected to statistical tests which return a "test statistic". From that test statistic a "p-value" is calculated. The p-value indicates the probability of observing the obtained results (or any more extreme value), when the

null hypothesis is true (e.g. chocolate has no effect on athletic performance).

In other words, the p-value is an indicator as to the statistical significance and consequential reliability of the results affirming the "alternate hypothesis"(not the probability that the null hypothesis is correct). It answers the question: If there is no correlation, how likely was it that I saw a correlation at least this big? Hence, if the p-value is low enough (by convention < 0.05), the null hypothesis is rejected, and we conclude that the alternate hypothesis is supported by the data (NOT that it is "correct" or "true").

In this comic, the p-value is corrected by a factor that takes clickbait into account. This factor has the effect of increasing the p-value if H1 is more clickbaity than H0, and decreases the p-value if H0 is more clickbaity than H1. This suggests that whatever clickers of clickbait believe, the reverse is likely to be true.

Furthermore, this factor may be interpreted as normalisation for the inherent selection bias where the p-values for more clickbaity H1s tend to be lower than they should be and p-values for non-clickbaity H0s to be higher than they should be. For example, one explanation could be that for p-values that are on the cusp of significance, researchers may be more incentivized to fudge and adjust the data to get the p-value down if the H1 is highly sensational, since the H1 would make the research more likely to get published and attract attention. (See also FiveThirtyEight's article on

p-hacking and this Stack Exchange question about p-hacking in the wild.) P-hacking has also previously already been associated with chocolate and media sensationalism.

As the statistical results now depend on people's beliefs about the hypothesis, this could appear as far from actual science as one can get. However, in a way, it is more in tune with a quote by John Arbuthnot (one of the originators of the use of p-values) attributing variation to active thought rather than chance, "from whence it follows, that it is Art, not Chance, that governs." Randall applying that quote to the thoughts of the masses brings it in line with "Art".

If this correction could be somehow enforced on the scientific world, it would have the effect of keeping the popular view of scientific results more in line with reality. Often one study will be performed that shows an exciting result, and consequently be sensationalised by the media prior to further studies to verify it. This is in part due to the conflicting interest of the scientific community and the media. The clickbait correction may aid a reader in exercising caution when interpreting sensationalist scientific discoveries in news media. Additionally, there can be a problem in some areas of science where more mundane results never undergo the third-party replication studies (see replication crisis), or perhaps are even never studied in the first place. The clickbait correction factor has the opposite effect on these more mundane topics, making it easier to demonstrate effects within them with a lower statistical

barrier for entry, perhaps in the hope that more will get studied, published, and exposed to the public.

Technically, the comic's depiction of null and alternative hypotheses is not entirely correct. As the alternative hypothesis (H_1) predicts that chocolate will improve performance (i.e., a one-tailed, directional hypothesis), the null hypothesis (H_0) should predict that chocolate will do nothing or make performance worse. In other words, the alternative hypothesis should be true if and only if the null hypothesis is false. For example, alternatively, if the H_1 were to say that chocolate will change performance (for better or worse; i.e., a two-tailed hypothesis) then H_0 should say that chocolate will do nothing.

The title text refers to Bayesian statistics, a statistical technique which involves considering (before you see the new data) how likely you think it is that the hypothesis is true. (It is worth noting that the traditional statistical analysis described above, doesn't directly say anything about how likely the hypothesis is to be *true*. It simply assesses whether the data is consistent with the null hypothesis.) Under Bayesian analysis, you begin with a prior probability, or simply just "prior", which expresses how likely you think the alternate hypothesis is. Then after seeing the new data, you apply Bayes' theorem to *update* your belief about the hypothesis, and as a result you should then consider the hypothesis to be more likely (or less likely) than you considered it before.

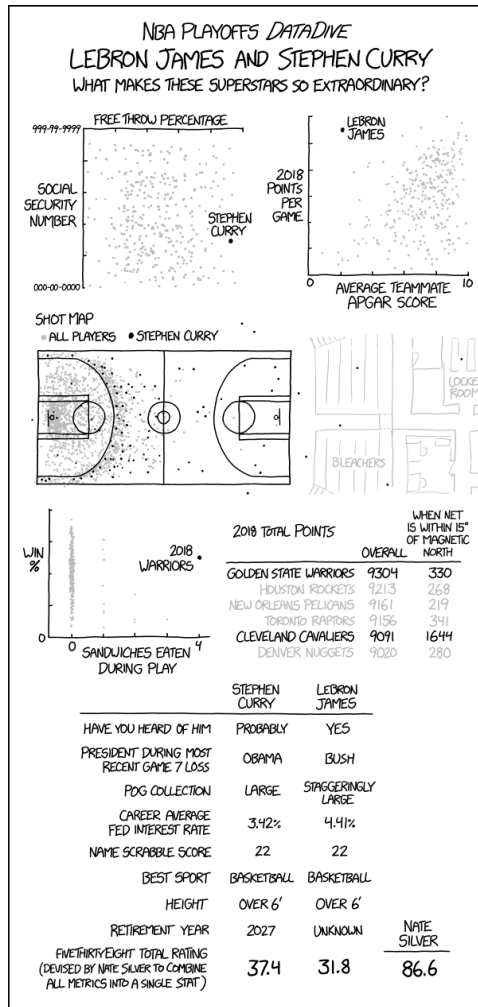
Bayesian statistics therefore recognizes that an

extraordinary claim should require more evidence to convince you than a "reasonable" claim would. (Which is, arguably, sort of, the same point being made by the Clickbait-correction.) But also that *enough* evidence, perhaps gathered step by step over time, should be sufficient to convince you even of extraordinary claims.

The technique can be hard to apply in science however, because of the difficulty in agreeing upon reasonable priors. Here it's suggested that an alternative "clickbayes factor" (a pun and portmanteau of clickbait and Bayesian) could be used to approximate hard to quantify priors.

#2002: LeBron James and Stephen Curry

June 04, 2018



The 538TR attempts to capture a player's combined skill at basketball (either real-life or NBA 2K18) and election forecasting.

Explanation

At the time of this comic, the 2018 NBA Finals were going on, between the Cleveland Cavaliers and the Golden State Warriors with the Warriors leading 2 games to 0 in a best of seven series. At first glance, the comic looks like an in-depth analysis of two of the star players on those teams, LeBron James and Stephen Curry. The joke is that while comprehensive, all the statistics are completely meaningless - many of them are obviously false, and many don't show any correlation, and if there is one, it's extremely unlikely there is any causal link in there.

The first graph includes a nine-digit Social Security number issued for US citizens which is typically not considered a metric related to athletic ability. As Social Security numbers are essentially random numbers (until 2011, there was a geographic correspondence for the first three digits), the graph shows only the free throw percentage of a large number of players, artificially spread vertically. Also note that Social Security numbers are not usually made public, barring security leaks.

The second graph is a graph of 2018 points per game vs teammate's APGAR score. APGAR score is used to quickly summarize the health of newborn children, with scores of 7 and above indicating an infant has generally normal health; its use to rank adult NBA players is odd, if not improper. This graph indicates LeBron's teammates have an average APGAR score of approximately 2.1.

Scores of 3 and below are generally regarded as critically low and possibly requiring medical attention. Low APGAR scores can also be associated with increased risk of neurological disorders such as cerebral palsy. The joke appears to be in giving LeBron's less-than-impressive teammates a low APGAR score.

The shot map shows from what position Curry's shots were scored compared to other NBA players. This references Stephen Curry's propensity to take (and make) shots from well beyond the normal distance required for 3 points. The comic then takes this to hilarious extremes by showing he supposedly scored several times from outside the playing field (not a legal play), including twice from the bleachers (definitely not a legal play), and once from the locker room (which is physically impossible due to multiple walls in between[citation needed]).

Next is a graph of (team) win percentage vs sandwiches eaten during play. Average win percentage seems to go down as number of sandwiches eaten goes up to 3. It does indicate that the Golden State Warriors still have quite high win rate even though they have eaten either 4 sandwiches per game, or 4 sandwiches total during games, over the course of the 2018 season (the graph is unclear on this point). Golden State Warriors seem to be an outlier as their win percentage is much higher than the one of the teams that have eaten 2-3 sandwiches.

In the "2018 total points" table, the highlighted Golden State Warriors and Cleveland Cavaliers represent the

teams of Stephen Curry and LeBron James respectively. Magnetic north is the south pole of the Earth's magnetic field. Certain animals use the magnetic field to navigate and align themselves (including migratory birds, bees, and foxes), but there is no evidence that humans are affected by the earth's magnetic field. This means that there should not be any correlation between orientation of a basketball court and points scored. But Cleveland Cavaliers have a much a higher percentage of goals scored when orientation is towards magnetic North than other teams, probably it is implied that LeBron James and/or his team somehow actually senses magnetic field and uses that to direct shots, but more likely explanation would be that it is just the orientation of the court during their home games.

The title text is a continuation of the joke in the bottom table. FiveThirtyEight, sometimes referred to as 538, is a website that focuses on opinion poll analysis, politics, economics, and sports blogging.

The table at the bottom includes more unrelated comparisons:

#2003: Presidential Succession

June 06, 2018

A PROPOSAL FOR A NEW PRESIDENTIAL LINE OF SUCCESSION

CURRENT POLITICS ASIDE, MOST EXPERTS AGREE THE EXISTING PROCESS IS FLAWED. THE PRESIDENTIAL SUCCESSION ACT OF 1947 IS PROBABLY UNCONSTITUTIONAL ON SEVERAL COUNTS, AND THERE ARE MANY PRACTICAL ISSUES WITH THE SYSTEM AS WELL.

(FOR MORE, SEE THE SURPRISINGLY GRIPPING SECOND REPORT OF THE CONTINUITY OF GOVERNMENT COMMISSION, JUNE 2009.)

PROPOSED LINE OF SUCCESSION:

1. PRESIDENT
2. VICE PRESIDENT
3. SECRETARY OF STATE
4. SECRETARY OF DEFENSE
5. SECRETARY OF HOMELAND SECURITY
6. ATTORNEY GENERAL
7. FIVE PEOPLE WHO DO NOT LIVE IN WASHINGTON DC, NOMINATED AT THE START OF THE PRESIDENT'S TERM AND CONFIRMED BY THE SENATE
8. TOM HANKS
9. STATE GOVERNORS, IN DESCENDING ORDER OF STATE POPULATION AT LAST CENSUS
10. ANYONE WHO WON AN OSCAR FOR PLAYING A GOVERNOR
11. ANYONE WHO WON A GOVERNOR'S AWARD FOR PLAYING SOMEONE NAMED OSCAR
12. KATE MCKINNON, IF AVAILABLE
13. BILLBOARD YEAR-END HOT 100 SINGLES ARTISTS #1 THROUGH #10
(FOR GROUPS, WHOEVER IS CREDITED FIRST IN NAME, LINER NOTES, ETC)
14. THE TOP 5 US ASTRONAUTS IN DESCENDING ORDER OF TOTAL SPACEFLIGHT TIME
15. SERENA WILLIAMS (OR, IF SHE LOST HER MOST RECENT MATCH, WHOEVER BEAT HER)
16. THE MOST RECENT SEASON NBA, NFL, MLB, AND NHL MVPs
17. BILL PULLMAN AND HIS DESCENDANTS BY ABSOLUTE PRIMOGENITURE
18. THE ENTIRE LINE OF SUCCESSION TO THE BRITISH THRONE
19. THE CURRENT CHAMPION OF THE NATHAN'S HOT DOG EATING CONTEST
20. ALL OTHER US CITIZENS, CHOSEN BY A 29-ROUND SINGLE-ELIMINATION JOUSTING TOURNAMENT

Ties are broken by whoever was closest to the surface of Europa when they were born.

Explanation

The United States presidential line of succession is the order of people who serve as president if the current incumbent president is incapacitated, dies, resigns, or is removed from office. The Presidential Succession Act of 1947 revised the presidential order of succession to its current order. This Act, though never challenged in the courts, may not be constitutional for two reasons. First, the Act names two members of Congress as successors. There are fundamental questions as to whether this violates the principle of Separation of Powers. The second issue is that the Act allows for anyone skipped over for succession to later assume the office if circumstances change to allow them to hold it. This would mean that the person in question could effectively unseat a sitting President, which raises serious constitutional issues.

There are also practical concerns regarding the Act. The line of succession includes all members of the Cabinet in the order that their department was established, with the oldest departments first. No consideration is given to which departments would be most relevant to the Presidency, particularly considering that this type of succession would presumably involve a serious crisis, which the new president would need to be able to address immediately. The Department of Homeland Security is in charge of the security and protection of the United States and its citizens and would probably already be privy to sensitive intelligence and briefings related to

national security, but because it is the latest of the Departments to have been established (in 2003), the Secretary of Homeland Security is last in the current Presidential line of succession, behind Secretaries in much less sensitive roles, such as those of Agriculture, Housing and Urban Development, and Education. Another concern is that, by including members of Congress immediately after the Vice President, there is a serious risk that the simultaneous death of the President and Vice President could cause the Presidency to change to the opposing party, which could lead to serious political instability at the precise moment when the country is facing a national crisis. It even presents the possibility that simultaneous assassinations of the President and Vice President could function as an effective coup, shifting power to their opponents.

Finally, there is the issue that, usually, everyone in the line of succession lives and works in Washington D.C. Hence, a sufficiently destructive attack or natural disaster impacting the city could realistically incapacitate all of them, leaving the USA leaderless at a time of extreme crisis. It is already established practice in the USA that everyone in this line not gather together at once. In cases where most senior government officials gather (such as the State of the Union), at least one member of the line of succession (referred to as the "designated survivor") is secured off-site, and would assume the presidency in the unlikely event that a mass casualty event were to kill or incapacitate everyone else in the line. However, disasters impacting an entire city remain a possibility, and no

provision is made for them in current law.

To correct these issues, a think tank known as the Continuity of Government Commission prepared a report recommending a new line of succession, which would not include members of Congress, would reorder the cabinet secretaries so that the most suitable roles would be the first successors, and would include people who do not live or work in Washington DC. The full text of their report can be found [here](#). A short, readable summary, including the report's recommended new line of succession, is [here](#).

The first six members of the commission's list are taken from the current line of succession, though the order is changed; they propose that after this, five new people should be appointed specifically for the purpose of assuming the presidency, if needed. Randall's list begins with these eleven people (combining the five new appointees into #7); afterwards, his list becomes increasingly comical and ridiculous.

Randall's list omits members of Congress, as well as other cabinet positions, in accordance with the report's concerns about constitutionality and qualifications. However, his other additions totally ignore these issues, including people with no apparent qualifications for the office (such as actors, athletes, and competitive eaters) and people who are constitutionally ineligible for the office. The US Constitution requires that the President of the United States must be a natural-born US citizen, at least 35 years of age, and have resided in the US for at

least fourteen years. Randall's list includes many people who don't meet these requirements. Most notably, he includes the entire succession to the British crown, almost none of whom meet the requirement of being natural-born citizens of the United States.

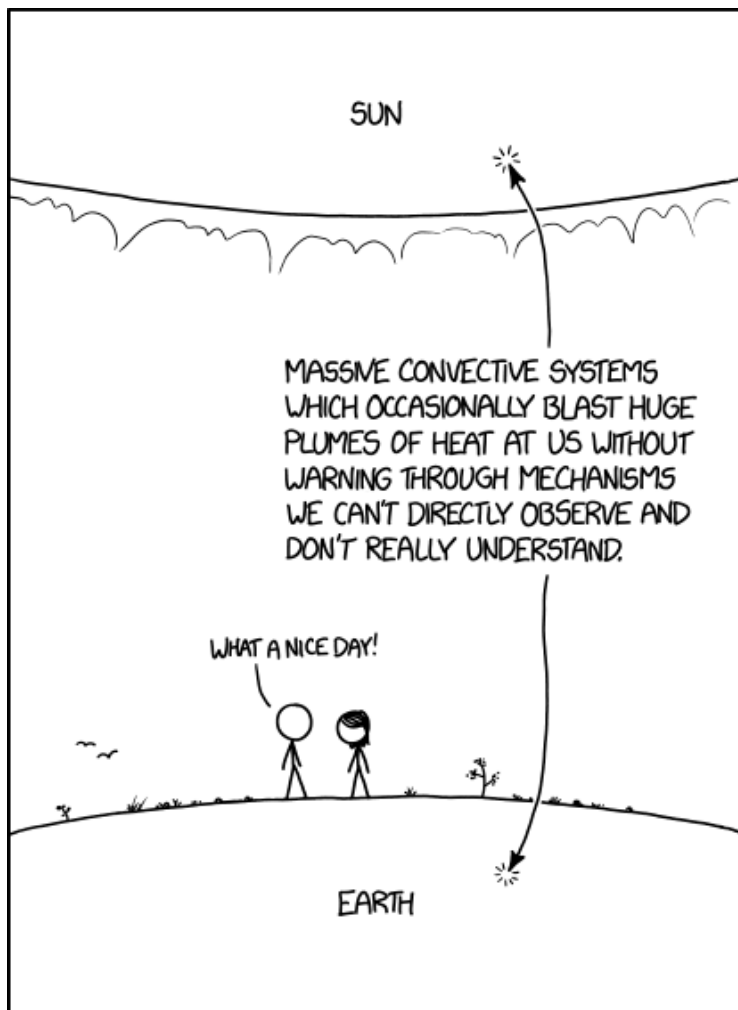
It may be expected that many of the athletes, musicians and actors on this list are likely to be ineligible as well. Most professional athletes in the relevant sports are under 35 years old, particularly those at the peak of their careers (when they'd likely win MVP awards), the most popular musicians also tend to be younger than 35, and many who meet these requirements were not born US citizens (and some many not even reside in the US). However, the existing line of succession can also contain ineligible people, who would simply be skipped over for succession. For example, at the comic's publication, Elaine Chao was the Secretary of Transportation and would normally be 14th in line, but because she is a naturalized citizen of the US, rather than native-born (she was born in Taiwan) she would not qualify for the office if the line came to her. The presidential line of succession was first mentioned in 1933: Santa Facts.

The title text mentions that ties will be broken by whoever was closest to the surface of Europa when they were born. Europa is a moon of Jupiter and one of the most likely locations in the Solar System for potential habitability. This is likely a parody of systems in which ties are broken by semi-arbitrary rules (such as the older candidate automatically winning a tie) or a randomized ones (such as ties being decided by a coin flip). The

position of Europa with respect to Earth at the time of one's birth depends on enough factors that it acts as a pseudo-random tie breaker, albeit a needlessly complicated one.

#2004: Sun and Earth

June 08, 2018



But we don't need to worry about the boiling masses sandwiching the thin layer in which we live, since we're so fragile and short-lived that it's unlikely to kill us before something else does! Wait, why doesn't that sound

reassuring?

Explanation

This is one of a number of comics which describe everyday events in unusual terms, making them sound really weird. In this case, both the Sun and the Earth are "massive convective systems [blasting] huge plumes of heat", which contrasts sharply with the daily idea of the Sun being a ball in the sky and the Earth the thing under our feet.

Free convection is based on an difference in density. What is colder is typically denser, so gravity forces it downwards, displacing what is hotter (and less dense) upward (This should not be confused with forced convection, which uses fans or other devices that are not practical to build on the scale of a planet). In the sun, most of the energy to drive this process comes from nuclear fusion, specifically the fusion of hydrogen into helium. We cannot directly see inside of the earth,[citation needed] but its core is known to be much hotter than its surface.

The magnitude of these systems gives you an idea of the size of the fluctuations you can expect. The sun is very massive, meaning the fluctuations in its convective or heat-dissipating behavior are very large. This is an instance of the Fluctuation-Dissipation theorem. These fluctuations take the form of a solar flare, as explained below. For a more thorough (but non-technical) explanation of the role of gravity and entropy in such systems, see this.

The Sun produces great amounts of light and heat and blasts it towards us, which is why we can live on Earth. Since Ludwig Boltzmann pointed out the fact in 1875, people have been working on establishing exactly how such far from equilibrium systems as life might depend upon, or be formed by (like this article), such massive entropy gradients as between the sun and earth (or rather the sun and empty space). Main sequence stars like the sun transport energy by radiation and by convective currents of plasma, bringing the heat generated in the core of the sun to its surface. These quickly moving charged particles create a massive magnetic field, which occasionally gets concentrated into a solar prominence which can snap, causing a large amount of charged particles to get shot into space as a solar flare. If the Earth happens to be in the direction of the solar flare, we can notice all sorts of interesting and often damaging effects. Thankfully, there are lots of other directions[citation needed] for the sun to shoot solar flares, so they don't come by the Earth that often.

The Earth's interior is also very hot. Mantle convection causes plate tectonics which is the main cause of volcanic activity (next to mantle plumes), which essentially also consists of huge blasts of heat.

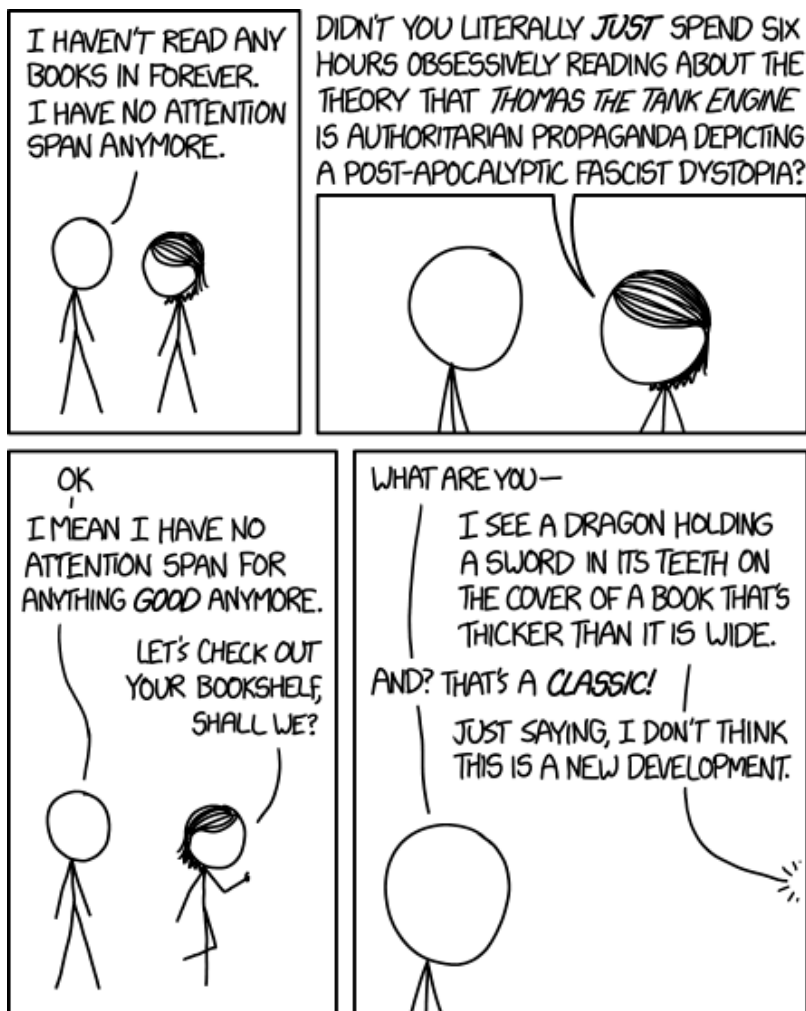
This could sound like a very bad scenario, but the title text reminds us that the real scenario we live in is far worse, as we are not likely to die from a Sun blast or volcano eruption. In doing this, he indirectly points out the hard truth about our lives: that they're limited and they're short, and it is far easier to die of because of other

things. In this way Randall attempts to give the reader an existential crisis; he concludes that his statement did not help to reassure himself.

This comic was likely inspired by the recent eruptions of the Kīlauea and Volcán de Fuego. In contrast, solar activity was low, as the sunspot solar cycle was nearing a minimum in 2018.

#2005: Attention Span

June 11, 2018



I didn't even realize they **MADE** a novelization of "Surf Ninjas." How did you-- Oh my god, it's signed by the author?!

Explanation

People often groan about their shrinking attention span, attributing it to an increased illiteracy. This allows for fond nostalgia about the times when they were supposedly more intelligent and focused. For instance, Nicholas Carr wrote this article to compile both anecdotes (which are more abundant) and research (which is more useful) to describe this phenomenon.

Cueball does the same here, but Megan retorts that he spent six hours reading over a pointless (if disturbingly plausible) theory about a banal show based off a series of bedtime stories made to entertain small children. Thomas The Tank Engine is a British children's series based off a series of books written by Wilbert Awdry. It follows the adventures of anthropomorphized train locomotives and other vehicles.

Cueball qualifies his statement: he has no attention span for anything good anymore. Megan, in reply, examines Cueball's bookshelf, finding a book that cements Cueball's status as a nerd who reads high fantasy. Cueball protests that the book is a classic, but Megan dismisses the fact.

To be fair to Cueball, many great fantasies have covers such as those in the comic (e.g. *A Song of Ice and Fire*, *The Lord of the Rings*, Randall's personal favorite *Discworld*). To be fair to Megan, this book is apparently not one of them, being thicker than it is wide (like *The*

Complete Miss Marple by Agatha Christie), a telltale sign of needless bombast and turgid prose.

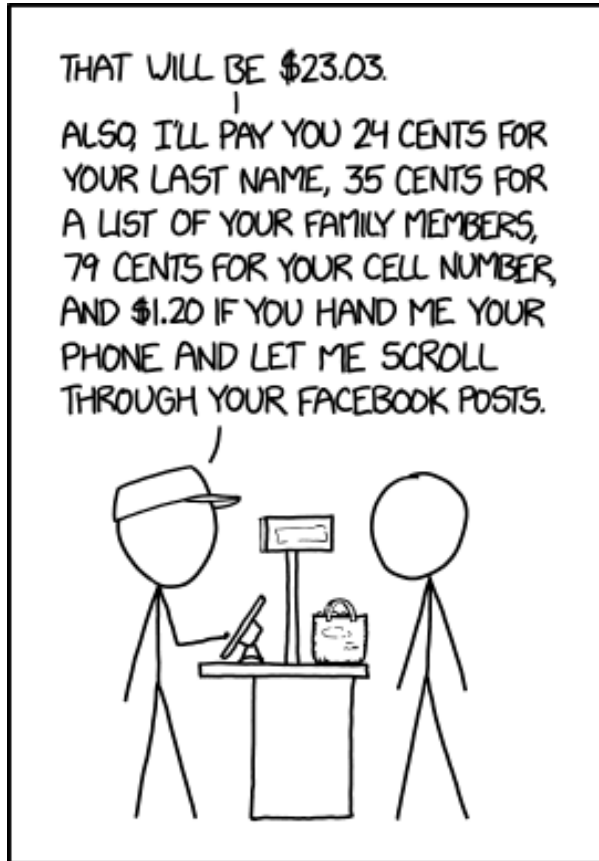
Other possibilities for the dragon book are His Majesty's Dragon from the Temeraire series or Dragonsbane from the Winterlands series.

If there was any doubt about Cueball's dubious literary tastes before, Megan dispels them in the title text, referring to a novelization of the excoriated movie Surf Ninjas, a movie that is exactly what it sounds like. Despite the hyperbole, the Surf Ninjas novelization is very much real, written by Peter Lerangis (under the pseudonym A. L. Singer); Lerangis would later move on from writing licensed works to his own original children's books and is now considered an accomplished author.

The comic contains a hyperlink to an article with the same unfortunate content Cueball has apparently finished reading prior to this comic: The Repressive, Authoritarian Soul of "Thomas the Tank Engine & Friends". This article, the articles linked from it, further linked articles from those, links found by googling the topic, and other related web surfing on the topic could easily add up to six hours or more of reading.

#2006: Customer Rewards

June 13, 2018



LOYALTY CARDS AND REWARDS ACCOUNT
OFFERS GET WAY WEIRDER IF YOU THINK
OF THEM AS SEPARATE TRANSACTIONS.

We'll pay you **\$1.47** to post on social media about our products, **\$2.05** to mention it in any group chats you're in, and **11 cents** per passenger each time you drive your office carpool past one of our billboards.

Explanation

Many supermarkets offer customers loyalty programs that give discounts. To join one of these programs you often need to give various personal data, such as your name, or download an app that can access your Facebook account. The supermarket gets lots of valuable marketing data to target the customer in the future. They think this will make lots of money for them, so they entice people to do this. This is why it is able to offer a discount to members of the program.

Here, Cueball is at a store where the clerk is offering to give him benefits in exchange for data and to help them advertise their products. This comic imagines the exchange of data for a discount as the sales clerk offering cash at the point of sale, to emphasize how odd this exchange is. Not to mention, when flat-out asking to see someone's phone to write down their contact info and look at all their Facebook posts it sounds disturbingly like uncouth data harvesting, not too far removed from potential identity theft.

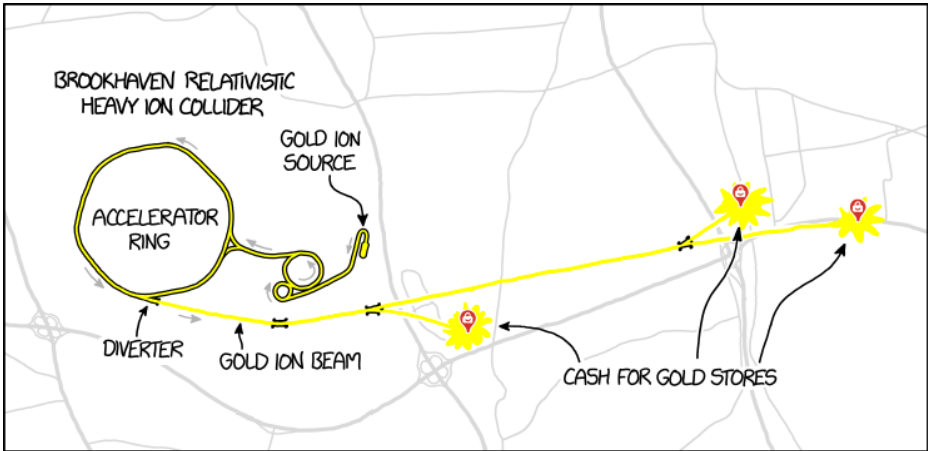
The title text continues this by considering how companies will also find ways to incentivize positive viral marketing or offer services in exchange for viewing adverts. Imagining these situations as if they were cash transactions makes them seem ridiculous.

All this information is used to send personalized ads which have a better chance of succeeding and earning

money for the store owner.

#2007: Brookhaven RHIC

June 15, 2018



SADLY, BROOKHAVEN REJECTED MY PROPOSED EXPERIMENT.

"Buddy, you trying to pull something? I can't buy this gold--all the electrons are missing. I could face serious charges!"

Explanation

The Relativistic Heavy Ion Collider is a particle accelerator designed to collide gold ions, sourced from gold foil, together at incredibly high speeds. This is normally done to study particle physics - the high-energy collisions allow us to learn more about how subatomic particles behave.

Randall proposes that, instead of using the beam of gold ions for particle collisions, it should be diverted and sold at cash-for-gold stores to make money. In effect, the particle accelerator would be reconfigured to become an extremely complicated and expensive method to transport gold ions from the foil to the cash-for-gold stores.

Randall proposed modifying part of the circular particle accelerator to add a diverter, so he can direct the gold ion beam to the three stores. It is unclear, however, how he would manage to transport the gold to the stores, as once it leaves the circular particle accelerator, parts of the beam are not in an enclosed space, and would likely collide with something. It would also cause problems once it reached the stores, as the gold ions travel at relativistic speeds.

Part of the joke may be that because they are traveling at relativistic speeds, the mass of the particles being sold will be much more than the mass of the ions being supplied to the collider's input. However, it would be very

difficult to sell a beam of charged particles,[citation needed] and the amount of gold involved is below microscopic scales. That, and the fact that he is trying to misuse the particle accelerator for his own profit, is the reason why Brookhaven "sadly" rejected Randall's proposal. Also, the energy used by the particle accelerator would cost more than the revenue from selling the gold.

Randall has done many comics describing impractical research proposals in the past.

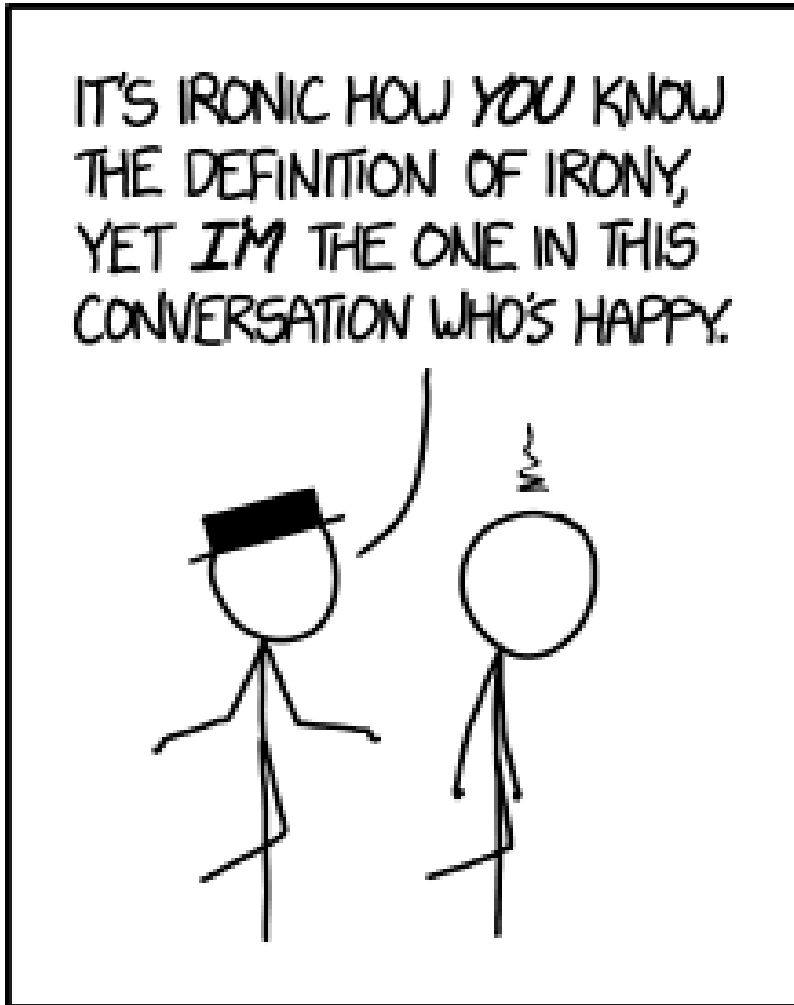
The title text imagines the owner of the stores complaining about the sale, not because of impracticality, but because Randall tries to sell gold ions with the entire positively-charged nucleus of the gold atom with all 79 electrons stripped from it instead of normal, electrically neutral gold atoms. This is also a pun on the word "charges", which could refer to electric charge or to criminal charges.

This is an actual map of the area around Brookhaven National Laboratory, with east at the top. The cash for gold stores depicted in the comic are, from left to right:

- New York Gold Center, 451 Glen Dr Ste D, Shirley NY 11967-1100
- Cash for Gold, 969 Montauk Hwy, Shirley NY 11967-2111
- Gold Traders Inc, 450 William Floyd Pkwy, Shirley, NY 11967-3480

#2008: Irony Definition

June 18, 2018



Can you stop glaring at me like that? It makes me feel really ironic.

Explanation

This comic presents a snapshot of an argument between Black Hat and Cueball. Black Hat states that it's ironic how Cueball understands the definition of irony, yet Black Hat is happy while Cueball is not. Cueball is upset because Black Hat is purposely misusing the term "ironic", likely after Cueball had previously corrected him on his use of the word.

Irony is a broad concept that is very often the subject of confusion and debate, especially concerning whether something is "really" irony. In this comic, Black Hat is probably referencing situational irony, which occurs when there is a sharp contrast between the expected and actual results of a situation, often in a humorous way or one that includes some sort of contradiction. For example, cane toads were introduced to Australia to control the native cane beetle, a pest to farmers. Ironically, the toads have caused massive ecological damage and become a pest themselves, and have even failed to control the cane beetles. That someone who understands what irony is would be unhappy while someone who doesn't would be happy is not an example of irony. Since Black Hat is trying to irritate Cueball, he is intentionally misusing the word "ironic".

Irony can have other meanings besides situational irony. Verbal irony (which is related to sarcasm) refers to a contradiction between a statement's stated and intended meaning. Dramatic irony is a device in fiction in which

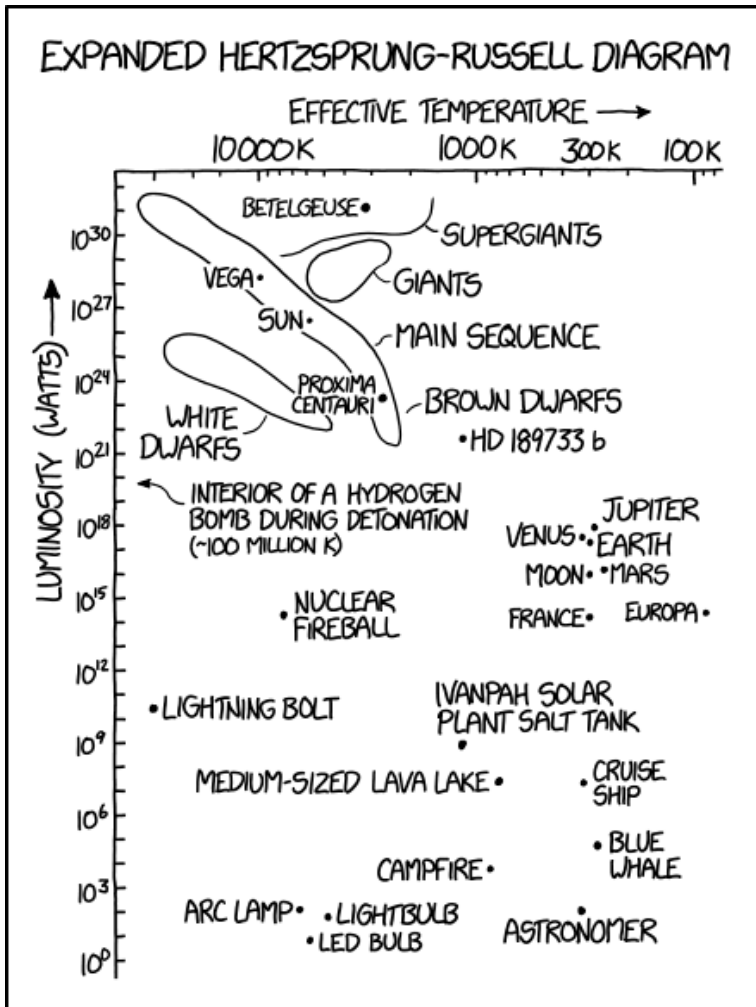
the consumer of a work is aware of information that is unknown to a character in the narrative. The adjective "ironic" is often used colloquially to mean strange, interesting, unexpected, or funny based on some subversion of expectations. The use of the word in these ways is often what prompts conversations and arguments about what really is or isn't ironic.

What could be going on is that Cueball was trying to correct Black Hat's misuse of the word irony, in order to make him feel bad about misusing it. However, Black Hat being the classhole he is, could have decided to take advantage of it, and misuse it again, to make Cueball angry again.

In the title text Black Hat once again misuses the word ironic, this time in an even more absurd way. It is unknown what Black Hat means when he says Cueball's glaring makes him feel "ironic", as this is a totally spurious use of the word, and one which is probably not intended to actually mean anything and is only done to annoy Cueball further.

#2009: Hertzsprung-Russell Diagram

June 20, 2018



The Hertzsprung-Russell diagram is located in its own lower right corner, unless you're viewing it on an unusually big screen.

Explanation

The Hertzsprung–Russell diagram is a scatterplot showing absolute luminosities of stars against its effective temperature or color. It's generally used to understand a star's age.

The axes are labeled in Kelvin (degrees Celsius above absolute zero) for effective temperature and, unlike many Hertzsprung–Russell diagrams, Watts for luminosity. While most Hertzsprung–Russell diagrams are labelled in units of solar luminosity or absolute magnitude, all three are perfectly valid measures of luminosity, which refers to the total power emitted by the star (or other body). Effective temperature refers to temperature of a black body with the same surface area and luminosity. This is meant to provide an estimate of the surface temperature of the object.

Roughly speaking, the luminosity (i.e. total power radiated) by an object is proportional to (1) the total surface area of the object, multiplied by (2) the (absolute) temperature raised to the fourth power. So a high luminosity generally results from either a very hot or a very large object, or a combination of the two. The surface-area dependence explains why the whale and the cruise ship are more luminous than the hotter campfire.

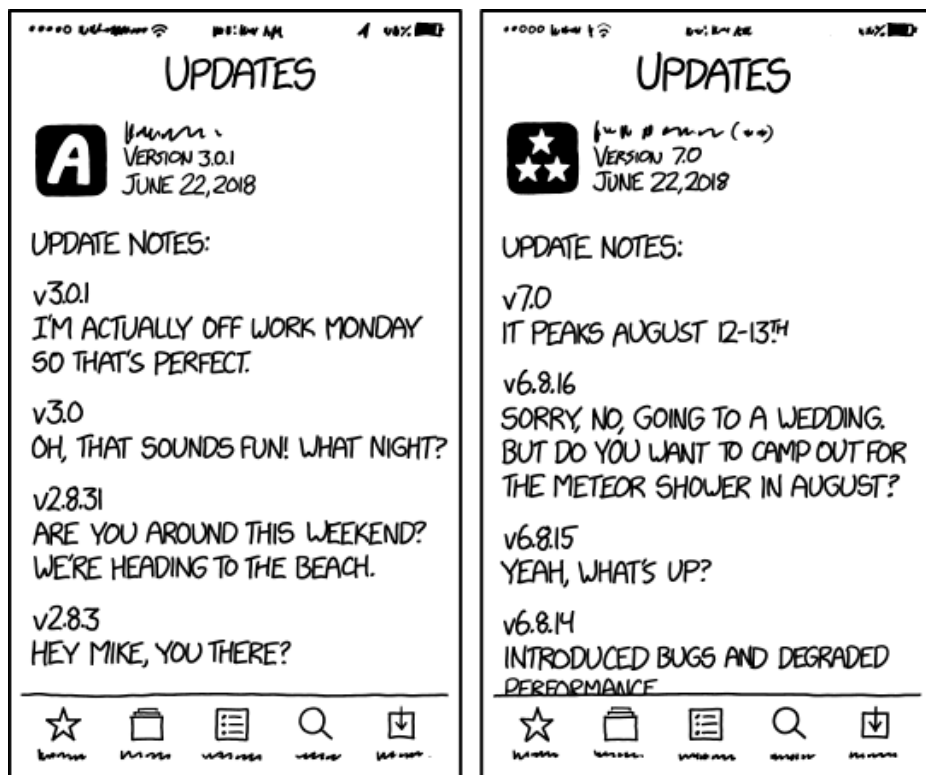
Regular Hertzsprung–Russell diagrams cover ranges of about 1,000K to 30,000K, and what is labeled on this diagram as 1021 to 1033 watts—i.e. the upper-left

corner. Extended diagrams increase the luminosity range only to include the "Brown Dwarfs". This diagram has been extended to much lower magnitudes on both axes. The joke comes from the absurdity of a diagram meant for stars including much smaller objects, such as planets ... and astronomers.

Though not included in the diagram, the title text notes that the diagram itself would probably be plotted somewhere in the lower right corner due to its (relatively) low power output and temperature. On its face this is nonsensical - the diagram itself, being mere information, possesses neither power output nor temperature - but one can read this as the power output and temperature of a typical screen displaying the diagram. Bigger screens have a higher total output (in terms of luminosity) and are thus positioned further towards the diagram's top. An "unusually big screen" would have to be something like a JumboTron or a projector for its luminosity or temperature to put it outside of the lower right corner.

#2010: Update Notes

June 22, 2018



MY FRIEND AND I BOTH HAVE APPS WE'VE STOPPED
MAINTAINING, SO WE JUST USE THE UPDATES TO CHAT.

v3.0.2: Hey, if anyone still using this app is headed to the beach, can you stop at 4th and River St and grab the sunscreen from my car? Trunk should be unlocked. Thanks!

Explanation

Update notes or release notes are notes (or documents) released when software has been updated, to inform the user of any important changes to the software.

In this comic, Randall and his friend are using release notes of their apps as a form of chat service, instead of actual software change information. He says this is possible because the two apps are no longer being maintained, so theoretically, there are not many people using the app who would read the update / change notes. Incidentally, one can still argue that the chat is still technically update notes, only instead of updating users on what has changed about an app, it is now giving Randall and his friend status "updates".

This comic has a similar theme as 1305: Undocumented Feature both use old software forums as a chat application.

This "chat service" would not be in real time, so presumably, Randall and his friend would have to be constantly checking each other's apps to see if there are updates.

On the "stars" app, the last "actual" notes says "Introduced bugs and degraded performance". This is a very common change when new features are added, however, developers will normally describe what the new features are rather than just state the negative

consequences. It goes in contrast with the typical change note "fixed bugs and improved performance" that usually follows.

The comic also refers to a meteor shower occurring in August, most likely the Perseid meteor shower.

The title text says that Randall, who is at the beach, has left his sunscreen in his car, but that the trunk (a pun with the name of the main software development branch in SVN) is unlocked, for whoever is still reading the updates for this app. This may invite the attention of thieves, who are now informed that Randall's trunk is unlocked. However they may not know what city Randall lives in, and conversely readers of the release notes could be anywhere in the world so most are probably not in a position to physically make contact with Randall's car.

This comic could be seen as a subtle reference to how plain sight communication such as gang codes and steganography are used by people, possibly out of coerced necessity, to communicate information both deniably and publicly. It is likely that this often happens in real app update messages in real life. This kind of communication would more realistically allow a criminal worker to communicate with a contact point without endangering their anonymity by associating with them directly.

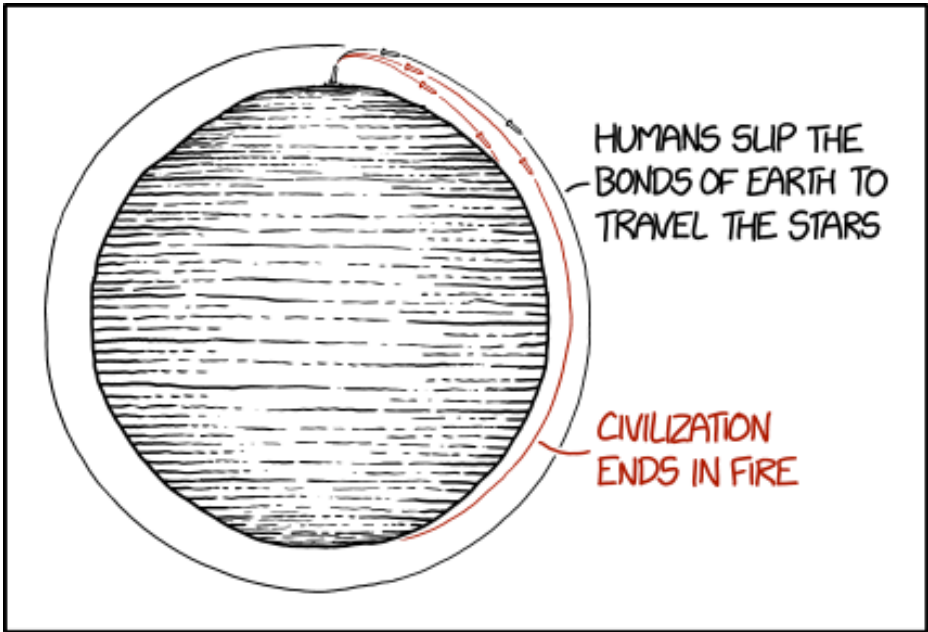
This comic could also be poking fun at the non-descriptive updates many popular apps post in the

"What's new" or change log. One example of this would be the Uber app stating "We update the app as often as possible" as a "new" feature every update. Apple recently changed AppStore guidelines to require clear descriptions of new features and product changes, effectively putting an end to the problem Randall is highlighting.

Realistically, even if it were permitted, this would be a rather slow form of communication, especially on platforms such as Apple's App Store, where Randall and his friend would need to wait from a few hours to a few days for their app to be manually reviewed for each "update".

#2011: Newton's Trajectories

June 25, 2018



IN RETROSPECT, NEWTON'S LITTLE CANNONBALL DRAWING DOES A SURPRISINGLY GOOD JOB OF ILLUSTRATING THE RANGE OF POSSIBLE FUTURES FOR OUR SPECIES.

With just one extra line, he could have anticipated the 2003 film *The Core*, but some things are too audacious for even the greatest visionaries.

Explanation

The comic shows the Earth, with three apparent rockets on separate trajectories. One is released with sufficient velocity to attain a stable orbit, while the other two fall towards the Earth. This is a slight modification of Newton's cannonball, a thought experiment demonstrating the planetary effects of gravity.

The black rocket trajectory is typically that of a rocket delivering a payload to low earth orbit. While a satellite in orbit is still bound to earth, it represents an important step in the history of space exploration. Today, a lot of scientific research regarding the future of human spaceflight is done from low earth orbit, most notably on the ISS.

The red rocket trajectories are suborbital, and more commonly associated with ICBMs. These are missiles typically equipped with nuclear warheads. Using such a weapon is likely to trigger a global nuclear war, with disastrous effects for civilization. It is worth noting that ICBMs normally use a different trajectory that goes much higher before falling down at a steeper angle. These trajectories are also different from FOBS, where missiles actually go into orbit (the black trajectory) before deorbiting and falling back on earth.

Here, Newton's cannonball is used both to observe humanity's technological future (interplanetary travel, availability of advanced technology to the masses, and

constant scientific improvement; or nuclear desolation and the extinction of our species) and to underscore that argument by pointing out the inherent metaphor in the experiment: the cannonball can only escape the atmosphere by achieving high velocity (i.e. escape velocity). Similarly, Randall's technological utopia will only deliver us from nuclear extinction if it happens quickly; otherwise, mankind will destroy itself. Of course, that threat only exists because of a triumph of technological progress, the Manhattan Project, but again, technology is a means to an end.

The phrase "slip the bonds of Earth" comes from the sonnet "High Flight" written in 1941 by John Gillespie Magee Jr., an American pilot in the Second World War. Portions of this poem appear on the headstones of many interred in Arlington National Cemetery, particularly aviators and astronauts; it was also quoted in President Reagan's speech after the Challenger disaster.

The title text alludes to the unfortunate film *The Core*, involving drilling to the center of the Earth to restart the stopped rotation of the magnetic core. The line is ostensibly aimed at the center of the Earth. Apparently, not even Newton could predict such a bold, daring and disastrous movie. Or movies.

#2012: Thorough Analysis

June 27, 2018

1. INTRODUCTION

THE DECEMBER 1811 EARTHQUAKE NEAR NEW MADRID, MISSOURI REPORTEDLY CAUSED CHURCH BELLS TO RING IN CHARLESTON, SOUTH CAROLINA.

BUT DID IT?

THE ORIGINAL BELL TOWER HAS BEEN LOST, BUT A COMPUTER MODEL OF THE CHURCH BUILDING WAS CREATED FROM ARCHIVAL PLANS AND FORENSIC MASONRY ANALYSIS. GENETIC TESTING OF TIMBER FROM LOCAL TREES RELATED TO THOSE USED IN THE BELL TOWER SHOWS A WEAKNESS IN THE

MY FAVORITE GENRE OF SCIENTIFIC PAPERS ARE EXHAUSTIVE 100-PAGE TREATISES THAT ANSWER SOME MINOR QUESTION WITH THE OBSESSIVE THOROUGHNESS OF THE 9/11 COMMISSION REPORT.

The likely shape of the bells was determined through consultation with several bellringing experts at the Tower of London. Transcripts of those interviews are available in Appendix VII.

Explanation

This comic remarks on how obsessively some scientific papers investigate some insignificant, obscure things. It gives the example of an investigation into whether an earthquake in 1811 caused church bells 600 miles away in Charleston, South Carolina to ring, which, although mildly interesting, is of minimal scientific importance. The earthquake itself is of enormous scientific interest, as an earthquake of the same magnitude in the same area today could cause enormous damage, but Charleston is not in the area considered at significant risk.

An explicit comparison is made to the 9/11 Commission Report, a study that was undertaken to, broadly, answer the question of how the September 11 attacks were able to occur (and by extension, what errors in security and communication needed to be addressed to improve detection of and response to other terrorist acts).

This paper describes the researchers going as far as to genetically test local trees, likely to find those most closely related to the trees used for construction, so as to measure their structural properties and extrapolate the likely structural properties of the original building. Such extrapolation might require its own study to back its validity. It is likely in real life that the small differences such research would reveal would end up being too unsubstantial to have actually warranted any searching.

The title text is a continuation of this paper, which

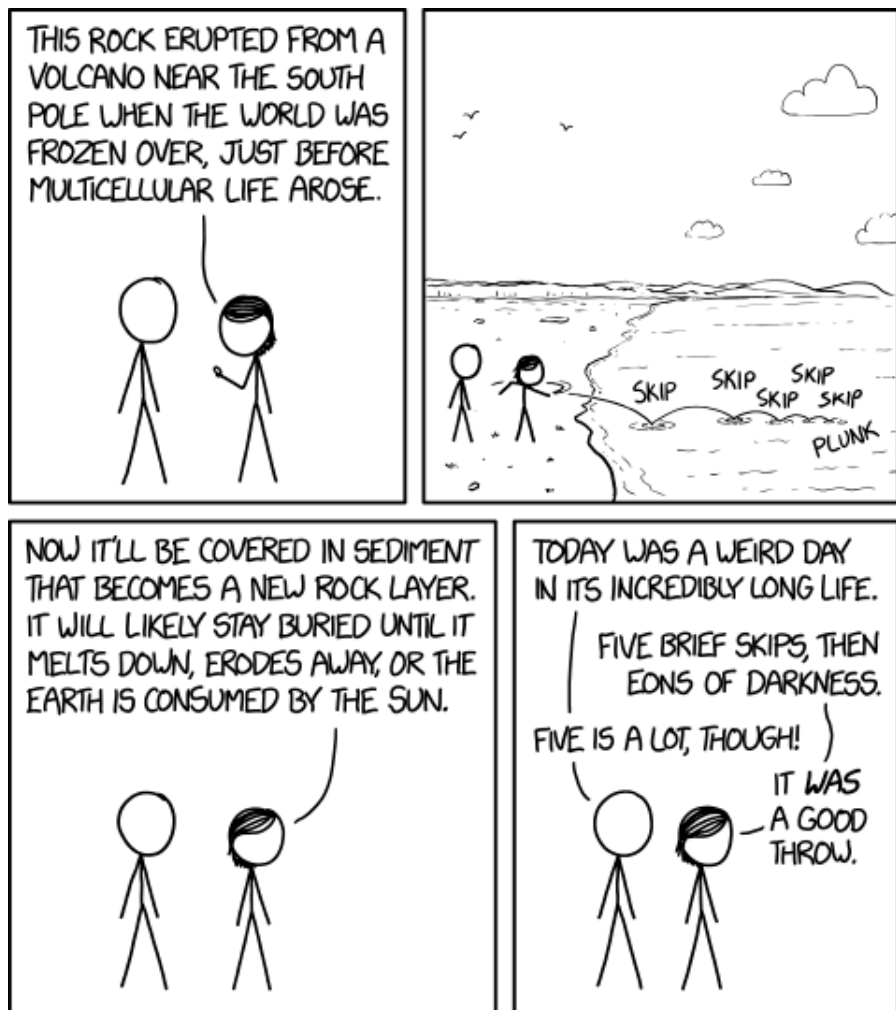
researches into the bells' shapes, and then goes on to note that the entire interview is provided in Appendix VII, indicating that this paper has a substantial amount of additional information considered distracting from the main body.

The Tower of London would be a strange place to seek expertise on church bells: even its Bell Tower contains warning bells rather than church-style bells (explain xkcd's transcript with the Tower of London officials on this manner can be viewed in Appendix B). Until 2017, the nearby Whitechapel Bell Foundry would have been a much better (arguably the best possible) source of information. Whites of Appleton (in Oxfordshire) or John Taylor & Co (in Loughborough) would be current alternatives. Closer to home for the paper's author, the McShane Bell Foundry in Maryland is likely to offer far more relevant expertise certainly than the Tower of London, and may in addition be able to offer relevant insights specific to the history of bellfounding in the USA.

In keeping with the meta thorough analysis theme of the original comic and this explanation, the comic starts with "The December 1811 earthquake near New Madrid, Missouri..." The town of New Madrid existed in 1811, but Missouri Territory did not exist until June 4, 1812, and the State of Missouri not until August 10, 1821.

#2013: Rock

June 29, 2018



It traveled so far to reach me. I owed it my best.

Explanation

Megan either knows enough about geology to tell on sight how this particular rock formed, or has brought this rock from a collection. Alternatively she's simply guessing. Despite admiring its formation, all she wants is to use it as a skipping stone to give it "a weird day in its life" (similar to 325: A-Minus-Minus), and possibly confuse future geologists.

Megan provides three pieces of information about the rock: It formed at the south pole, during an ice age, just before multicellular life developed. Unfortunately, due to disagreements among geologists and palæontologists about when exactly the first multicellular life emerged it is unclear which time Megan refers to - and consequently where she is and what kind of rock she is holding. There are two possibilities:

Thus — assuming that Megan has accurately identified the stone — the stone is either from Western Africa or Northern Europe and has "travelled" from there to get to her.

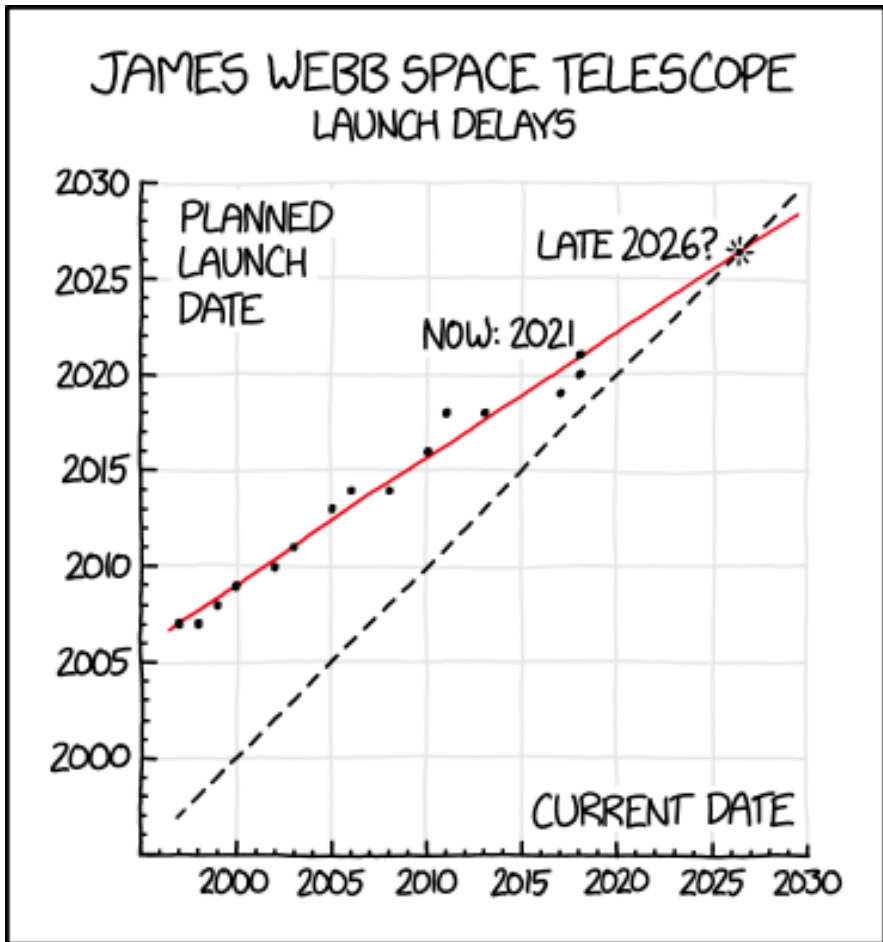
Stone skipping is the art of throwing a flat stone across water in such a way that it bounces off the surface. Despite there being many factors attributed to successfully skipping a stone (including the attributes of the stone itself), Cueball and Megan are in agreement that skipping this particular stone five times is an above-average throw. (It is, however, far short of the

world record of 88 skips set by Kurt Steiner in 2013).

This comic is one of many that look at everyday things from a new, philosophical perspective.

#2014: JWST Delays

July 02, 2018



LOOK, AT LEAST THE SLOPE IS LESS THAN ONE.

Since delays should get less likely closer to the launch, most astronomers in 2018 believed the expansion of the schedule was slowing, but by early 2020 new measurements indicated that it was actually

accelerating.

Explanation

The James Webb Space Telescope (JWST) is a space telescope created to be the successor of the Hubble Space Telescope.

The telescope has been in development since 1996, but has been plagued by numerous delays and cost overruns. This comic was likely inspired by the most recent delay announcement, which was posted on June 27, 2018. At that time, the JWST was scheduled to launch on March 30, 2021.

- In July 2020, this was pushed back further to October 31, 2021 due to the coronavirus pandemic.
- In June 2021, it was announced that the launch day will likely slip to at least mid-November 2021.
- On September 8, 2021, ESA announced that the official planned launch date is December 18, 2021.
- On November 22, 2021, NASA announced that the official planned launch date was delayed by four days to December 22, 2021, following a problem encountered when mating JWST to its payload adapter. This date was referenced in 2550: Webb.
- On December 15, 2021, NASA announced that the official planned launch date was delayed by two days to December 24, 2021, following a communications issue between JWST and the launch vehicle
- On December 21, 2021, NASA announced that the

official planned launch date was delayed by one day to December 25, 2021 due to adverse weather at the launch site

- On December 25, 2021, the telescope was successfully launched, which Randall anticipated with this comic: 2559: December 25th Launch.

This comic portrays the launch delays and the new predicted launch years and the times at which those predictions were made. There have been so many delays in this project that you can plot a line of best fit with a surprisingly high degree of accuracy. Randall says optimistically that the line's slope is less than one (there is less than one year of new delay per year of elapsed time), implying, of course, that if events continue without further intervention, it will eventually be built, with a predicted launch date of late 2026.

The title text alludes to the famous research over the universe's accelerating expansion. The expansion had been predicted to be slowing due to gravity from everything in the universe; instead, it was found to be accelerating since about 5 billion years ago. Here, Randall looks at the apparently ever-delaying schedule and observes that the delay per time does not decrease, although the date gets nearer (which should help to schedule the launch date, as research and unknown parameters are replaced with engineering and exact predictions and measurements). However, this delay inflation contradicts Randall's usage of a linear trendline.

Given the COVID-19 pandemic brought some

additional delays in 2020 and 2021, the "early 2020" date was perhaps unintentionally prescient.

The Wikipedia article linked above includes a table which provides the data points for the chart:

#2015: New Phone Thread

July 04, 2018



I'm going to tell the manufacturer that their business practices are **ADMIRABLE** and **ETHICAL** and their developers are **ATTRACTIVE** and I'm going to report them to the FCC for their **IMPECCABLE VIRTUE**.

Explanation

This comic shows the posts on an online forum by a person whose new phone is programmed to autocorrect every complaint about the phone to applaud it, à la Orwell. The phone goes as far as to change a certain complaint to a scripted customer testimonial, complete with a hyperlink to an ordering site. This is of course a highly undesirable feature.[citation needed] This is continued in the title text, which presumably contains several flattering compliments about the great developers and the company.

"It's taking the words I type and leaving them exactly the same", "I mean the words are correct" and "some of my posts look normal" are definitely something one would not normally say. However, the auto-correct features of cell phones are so notorious for mangling people's posts, that one might express astonishment at a phone which did not change one's meaning. The rest of the thread does not support this interpretation.

The posts also make sense when being read in the reverse order. The comic may have been inspired by a bug in Samsung Galaxy S9 and Note 8, discovered a few days earlier – the phone sometimes sent random photos to contacts without leaving any sort of evidence. This doesn't happen with the Mobile Pro 3.

The original posts may have read something like this:

#2016: OEIS Submissions

July 06, 2018

SUB[43]: ALL INTEGERS WHICH DO NOT
APPEAR IN THE EXAMPLE TERMS
FOR ANOTHER OEIS SEQUENCE

SUB[44]: INTEGERS IN INCREASING ORDER OF
WIDTH WHEN PRINTED IN HELVETICA

SUB[45]: THE DIGITS OF CHRIS HEMSWORTH'S
CELL PHONE NUMBER

SUB[46]: ALL INTEGERS, IN DESCENDING ORDER

SUB[47]: THE DIGITS OF THE OEIS SERIAL
NUMBER FOR THIS SEQUENCE

SUB[48]: 200 TERABYTES OF NINES

SUB[49]: THE DECIMAL REPRESENTATION OF
THE BYTES IN THE ROOT PASSWORD
TO THE ONLINE ENCYCLOPEDIA OF
INTEGER SEQUENCES SERVER

OEIS KEEPS REJECTING MY SUBMISSIONS

SUB[59]: The submission numbers for my accepted OEIS
submissions in chronological order

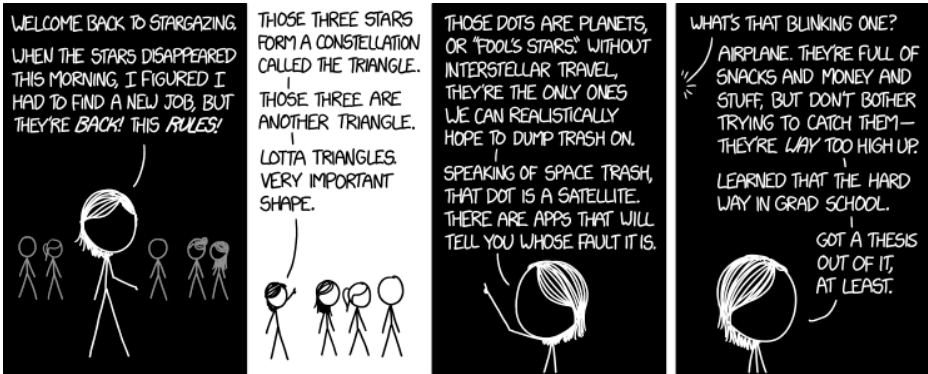
Explanation

The OEIS is the Online Encyclopedia of Integer Sequences, a listing of hundreds of thousands of sequences of integers, generally of real mathematical interest, such as prime numbers (A000040) or Armstrong numbers (A005188). They would not be interested in the personal or idiosyncratic sequences proposed by Randall, though they do have the list of subway stops on the New York City Broadway line (IRT #1), perhaps because a NY Times article mentioned that they don't. The OEIS wiki gives examples of sequences that were rejected and even mentions xkcd.

Randall is trying to put his integer sequences on the OEIS website, including making OEIS reveal its password.

#2017: Stargazing 2

July 09, 2018



I mean, it wasn't exactly MY thesis. When the FAA came to shut down our observatory for using the telescope mirror to shine light at airplanes, I took a thesis and a bunch of doctorates from the supply cabinet on my way out.

Explanation

This is the second comic in the Stargazing series, and it followed 1644: Stargazing that came out two and a half years prior. It was followed by 2274: Stargazing 3 one and a half years later.

This comic continues with Megan as a TV host mixing accurate astronomical information with trivialities, as well as utterly bizarre statements. (See this section from the original Stargazing comic about the host and also the trivia, from the original comic, regarding the gender of the host).

In the first panel, the host voices surprise that the stars are visible again after disappearing during daylight.

The host mentions three stars in a constellation which she says is called The Triangle, likely referring to the constellation Triangulum, which is in fact just three main stars in a narrow triangle. However, this may also simply be intended to show the host's lack of knowledge of constellations, since she then goes on to point out three other stars forming a triangle and concludes that one can form lots of triangles by connecting groups of three stars. In Euclidean and non-Euclidean geometry, any set of three non-collinear points will form a triangle, so to say that there are a "lotta triangles" is both trivial and an understatement.[citation needed] (There are about 125 billion triangles visible in the night sky with around 9096 visible stars.)

Then she points to planets, calling them dots known as "fool's stars" (like fool's gold). Planets such as Venus and Jupiter are often mistaken as stars, and the word itself is derived from the Greek, *planētēs* or "wanderer." She also notes that lacking interstellar transportation, humanity will likely only reach the planets within our solar system. However, she then makes the seemingly ludicrous assertion that humans will turn these planets into interplanetary landfills, which might be a comment on how humans have used the Earth. See 2633: Astronomer Hotline where an astronomer calls fireflies "ground stars" and other names.

The host also notices a dot of "space trash": An artificial satellite. Since the nascent Space Age, the Earth's orbit has gradually accumulated artificial materials that include satellites, spent rockets, and space stations. There are concerns such debris accumulation will increasingly imperil current and future space projects. However, the host claims there is an app that can tell you "whose fault it is," presumably a satellite-tracking smartphone app such as SkyView which can inform you who launched a given satellite and thus whose "fault" that particular bit of space-junk might be.

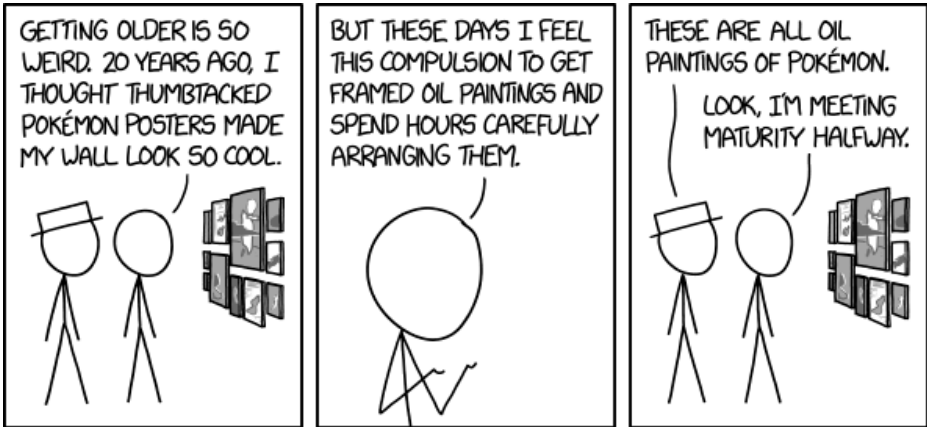
The host eventually goes off on a tangent when someone from the audience points out something blinking in the sky. The host says it is a plane, and tells them what is inside it. The host continues, "don't bother trying to catch that one." This could be understood as she means it's too hard to point the telescope at it properly because it is moving too fast. In the title text, however, she means

this literally, revealing that at one point during her studies she apparently used the reflective mirror of a telescope to shine light directly at airplanes, which caused the Federal Aviation Administration (FAA) to close down the observatory. She claims it was worth getting shut down by the FAA because she completed her thesis for her graduate degree. "Got a thesis out of it" is a phrase typically used by a scholar after discussing a research project, as a way of indicating that it was actually the main research they had conducted as a student in graduate school. Conducting research and writing it up in a thesis is one of the major hurdles toward earning a graduate degree (masters or doctorate).

In the title text, she clarifies that as she was exiting the observatory, she literally "got", as in "stole", someone else's thesis paper and multiple doctorates (presumably framed degrees), either to fraudulently claim them as her own accomplishments, or perhaps just because she wanted to steal stuff. Usually "got a thesis" is shorthand for the process of "writing a lengthy thesis paper and having it be accepted as a requirement for graduation", however in this case she simply swiped someone else's document. The revelations that she's extremely unqualified (and unethical) would explain her many bizarre statements.

#2018: Wall Art

July 11, 2018



At first, I moved from pokmon posters to regular oil paintings, but then these really grumpy and unreasonable detectives from the Louvre showed up and took them all. They wouldn't even give me back my thumbtacks!

Explanation

Pokémon is a media franchise managed by The Pokémon Company, which started with the release of the first video games, Pokémon Red and Blue, for the Game Boy in 1996. Originally released in Japan as Pokémon Red and Green, the game was released in North America as Pokémon Red and Blue in 1998, 20 years ago at the time of publishing.

This is another comic about getting older. Cueball mentions that he thought Pokémon posters were cool 20 years ago (when Pokémon was first released). Now that he is older, he instead has framed oil paintings, which were what wealthier older folks were displaying on their walls at the times that their teenagers were widely into Pokémon. The punchline comes when White Hat mentions that his oil paintings are just paintings of Pokémon characters, showing that Cueball hasn't completely adopted those older cultures in 20 years of maturing, but does have more money.

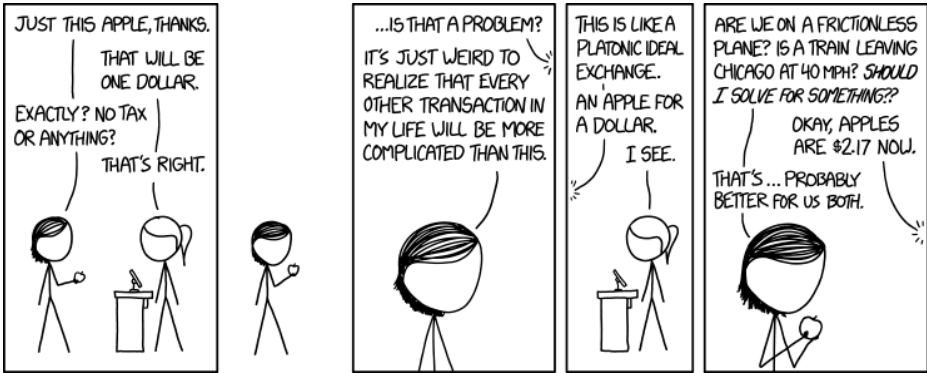
The title text mentions that Cueball originally had "regular" oil paintings. However, these appear to have been stolen from the Louvre, a famous art museum in Paris, which houses the Mona Lisa. Thus the "grumpy and unreasonable" detectives which came to retrieve the paintings. It even suggests that Cueball had attached those valuable and expensive oil paintings on his wall by poking through them with thumbtacks. The fact that Cueball stole expensive paintings, poked them with

thumbtacks, and did not realize that the detectives were trying to recover priceless artwork that rightfully belonged to the museum may demonstrate that Cueball indeed has not completely grown up.

The comic repeats a common theme of poking fun at how nerds tend to not fully "get" the culture surrounding them, adopting parts but remaining completely blind to other parts. Sharing and reading jokes about this may help people who experience that pattern handle the stress of being unable to completely conform, by bonding over the commonality.

#2019: An Apple for a Dollar

July 13, 2018



I'd like 0.4608 apples, please.

Explanation

Megan is about to buy an apple at a grocery store when she is surprised that the price is exactly one dollar. A common practice in pricing items is to deliberately make them slightly less than a round number, such as \$1.99 or \$1.95 instead of \$2, as a psychological trick to make the item seem significantly cheaper than it really is, as "less than two dollars" sounds much less than "two dollars" even though the difference of 0.01 is minimal. Additionally, in most cases in the US, sales tax must be taken into account, as it is generally not included in the list price (although, most states do exempt food sold in grocery stores from sales taxes), so a price rarely comes out to a round value. That it came out to an exact dollar is so strange for Megan that it throws her for a loop. Buying one apple for one dollar feels to her more like a simplified, imaginary Idea of a transaction (a "Platonic Ideal") than like something that could actually happen in real life.

Megan likely shares Randall's background in engineering and math. When learning science, engineering, and math in the education system, one studies examples where every number is some round value, and all situations are simplified to the barest essentials so as to demonstrate the ideas being taught. Then, when doing real problems in the real world, one spends the rest of one's life almost never being able to use the simplified tricks demonstrated as examples in school, because when math is used to describe the natural world, nothing is ever a round

number unless by design.

Megan references Platonic Idealism, which is the theory attributed to Plato that abstract or non-physical Ideas represent the purest, most accurate version of reality, but we can only perceive of more flawed versions of Ideas because of our limited viewpoint (as explained in his Allegory of the Cave). Thus we can understand the concept of a perfect circle or a perfect line, even though we have never seen one, and cannot create one. Megan believes she has glimpsed a Platonic Ideal because the absolute concept of currency is it is the exact worth of something in trade. Megan is awed because, if this is true, then she is witnessing the next layer of reality, which Plato often compared to heaven.

The harsh difference between being able to buy an apple for a dollar at this quaint store, and having to deal with arbitrary decimals and numbers in the rest of life could be touching on Megan's life experience of the world not being what she was prepared for, resulting in her intense response. Regardless if that is true or not, it seems the cashier is unable to figure out how to handle it (or does not want to), and raises the price to an arbitrary non-rounded value, which has the intended effect of halting Megan's outburst. The unexpected resolution of the rising tension is a source of humor in this strip.

Megan's references refer to common parameters used in solving science or math questions. A frictionless plane is a scenario from the writings of Galileo to calculate the movement of an object down an inclined plane, since his

equations did not account for friction. Frictionless spaces have been mentioned back in 669: Experiment.

"A train leaving Chicago at 40 mph" refers to common math questions, involving trains and solving for the distance required to encounter said train, although this problem involves the rather unrealistic assumption that the train's velocity keeps constant and doesn't need to accelerate in order to reach its speed. Like the frictionless plane, this is a common simplification that allows the problem to be solved with quite simple techniques, just like having round quantities (e.g. 1 dollar/apple) eases arithmetic problems. Apples themselves are commonly used as units for math problems, including problems as simple as basic arithmetic.

The comic repeats a common theme in the strip of engineers and computer scientists trying to apply their technical experience to social situations. In this case, the conversation partner is "normal", and does not respond supportively, which is a common situation in the real world and a possible point of empathy with readers. -- An alternate viable reading is that the conversation partner responds extremely supportively (by cleverly removing the source of Megan's distress, rather than by questioning the validity of Megan's response). This is a possible point of wish-fulfillment for readers.

It seems that according to the title text, Megan only has (or only wants to spend) one dollar, so she would not be able to buy a whole apple at the new price ($0.4608 \times \$2.17 \approx \1). Stores usually sell whole apples, so asking for

a fraction of one is not likely to work out.[citation needed]

At the time that this comic was made, there used to be stores (such as Dollar Tree) that sold all kinds of their items for only a dollar. However, in 2022, the last of these thrift chains, Family Dollar, finally stopped selling items for merely a dollar or less: although, some stores (including other fellow dollar store brands) likely still sell items for this meager price, at least in some regions.

#2020: Negative Results

July 16, 2018

DEAR NATURE MAGAZINE,

I FOUND NO EVIDENCE SUFFICIENT TO REJECT
THE NULL HYPOTHESIS IN ANY RESEARCH AREAS
BECAUSE I SPENT THE WHOLE WEEK PLAYING
THE LEGEND OF ZELDA: BREATH OF THE WILD

I'LL SEND YOU ANOTHER UPDATE NEXT WEEK!



THE PUSH TO PUBLISH NEGATIVE RESULTS SEEMS
KINDA WEIRD, BUT I'M HAPPY TO GO ALONG WITH IT.

P.S. We're going to the beach this weekend, so I'm attaching
my preregistration forms for that trip now, before we
find out whether it produces any interesting results.

Explanation

Recently, scientists have begun encouraging each other to publish negative results, where a study failed to find the intended effect, as a way of counteracting publication bias (where only interesting positive results get published), which results in false-positive results being published while negative results are not.

Cueball misinterprets the "push to publish negative results" as meaning that he should always attempt to publish the fact that he failed to find evidence of an effect, even when he didn't even try, spending his time playing a video game instead. This plays on the unspoken assumption that scientists would only choose to submit (and journals would only accept) negative results where a study was designed and executed well enough that it should have shown an effect or at least demonstrated evidence of some kind.

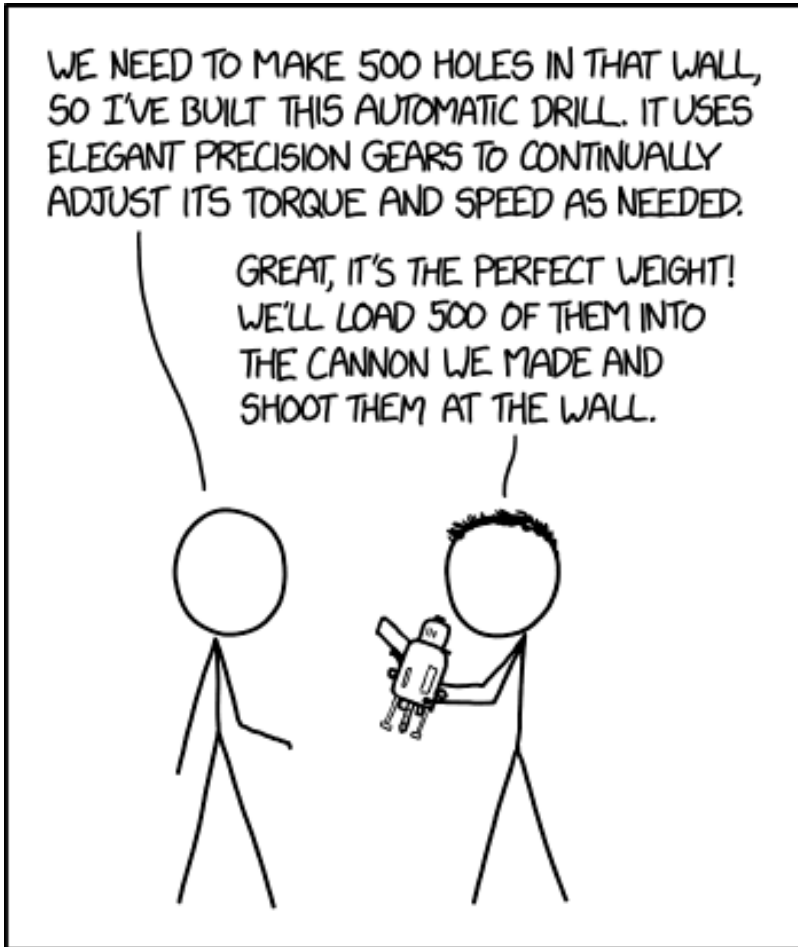
Besides personal preferences, *The Legend of Zelda: Breath of the Wild*, the most recent Legend of Zelda game at the time of publication, was likely chosen for its notable length, Nintendo nerd cred, and a relevance to Nature magazine's subject. The average time to beat 100% of the content is over 175 hours.

The title text references the practice of "pre-registration" of a study, which is one means to prevent publication bias: details of a planned study are registered with an organization before the study is conducted, so that a null

result or a change in methodology cannot be hidden. The title text may be a play on words, mixing this up with registering (or booking) travel. On the other hand, it may just be playing on the absurdity of pre-registering a simple trip to the beach with a registry for scientific studies.

#2021: Software Development

July 18, 2018



HOW SOFTWARE DEVELOPMENT WORKS

Update: It turns out the cannon has a motorized base, and can make holes just fine using the barrel itself as a battering ram. But due to design constraints it won't work without a projectile loaded in, so we still need those

drills.

Explanation

Software development is often characterized by graceless solutions to rudimentary problems. Cueball has built an elegant drill (function) that can adjust torque and speed as necessary automatically to fulfill his requirement of 500 holes in the wall. Hairy, in a categorically inelegant solution, loads 500 drills into a cannon and shoots them at the wall. This solution, in reality, would entail too many ludicrous safety problems to execute, but in software, the implications are only really bad code.

The casual disregard for the software itself is reminiscent of the idea of cattle not pets when deploying to servers.

This resembles assigning two different software teams to resolve different parts of a problem and of making the independent tools collaborate to form a fluid solution. The so-called "drill team" is given the task of making the part of the system that makes a hole in the wall. The cannon team was given the task of making the part of the system that aims what the drill team produces at the designated place on the wall and subsequently drills the hole. The drill team assumed that the aiming device would merely position their portion on the wall allowing it to make the hole, but the cannon team could not make assumptions about how the drill team would generate holes - they needed to make something that could use whatever the drill team produced to make the holes, thus making a cannon, so they could ensure their success.

The title text is a joke about how often in software the best solution to a problem is general rather than specific. See for example developers using Ruby on Rails (a full web framework with support for emails, templating, and web sockets) for a simple API-only service. They only need a very small part of rails (the hole drilling part), but end up with the whole framework anyway due to design limitations.

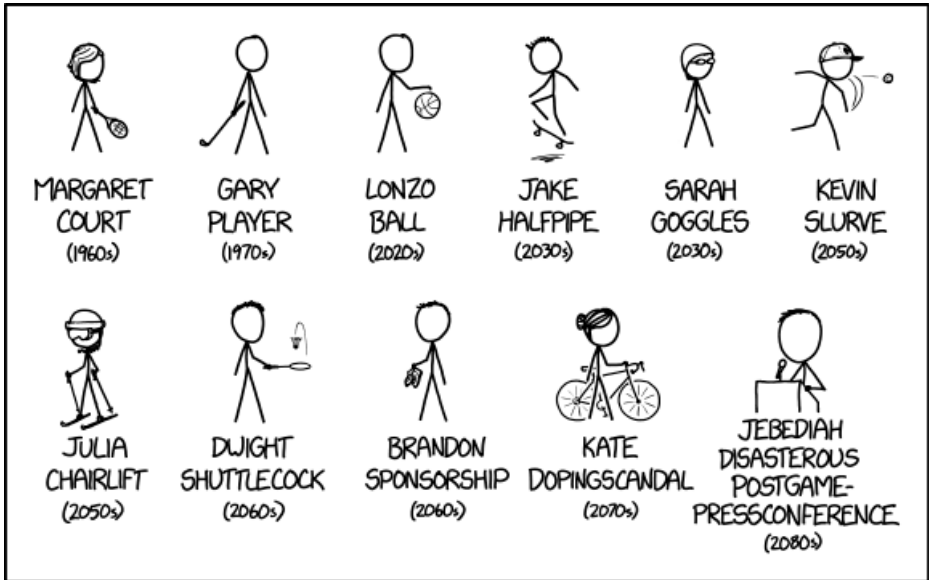
Another explanation of the title text is that software development is also often characterized by complexity and unintentional interdependence between different modules of code. It is an unending source of frustration for coders that a seemingly minor change to code can cause major changes to how the program works, including changes seemingly unrelated to the specific code that changed. A similar problem is when a line of code that “should be” unnecessary (according to the rules of the programming language) ends up being essential because the program will not work if the code is cleaned up and the line removed. A final factor is that coders often write a particular function once in the first module, and then call back to that function when necessary in subsequent modules rather than rewriting the function over and over again. In that case, the first module cannot be eliminated, even if it is no longer necessary, because then all of the calls to the original function would be null, and the rest of the modules could not work. This can happen not just within programs but across them, as much software on the internet relies on large collections of program modules in public or open source software

databases. When a module goes missing it can have wide ranging effects, as seen in March of 2016.

In the context of the comic, it could be that the code for the cannon was written to check if it is “loaded” before it does anything, so the drill code is still needed to get the cannon to move on its motorized base and make the holes. Or the code for the drill defines an obscure variable that is used by other code for the cannon or its base, so “removing” the drill code would cause the cannon to “crash” and not operate.

#2022: Sports Champions

July 20, 2018



FUN FACT: EVERY SPORT EVENTUALLY PRODUCES A CHAMPION COMPETITOR NAMED AFTER A COMMON ELEMENT OF THE GAME.

For a long time, people thought maybe Usain Bolt was the one for running, until the 2090s and the incredible dominance of Derek Legs.

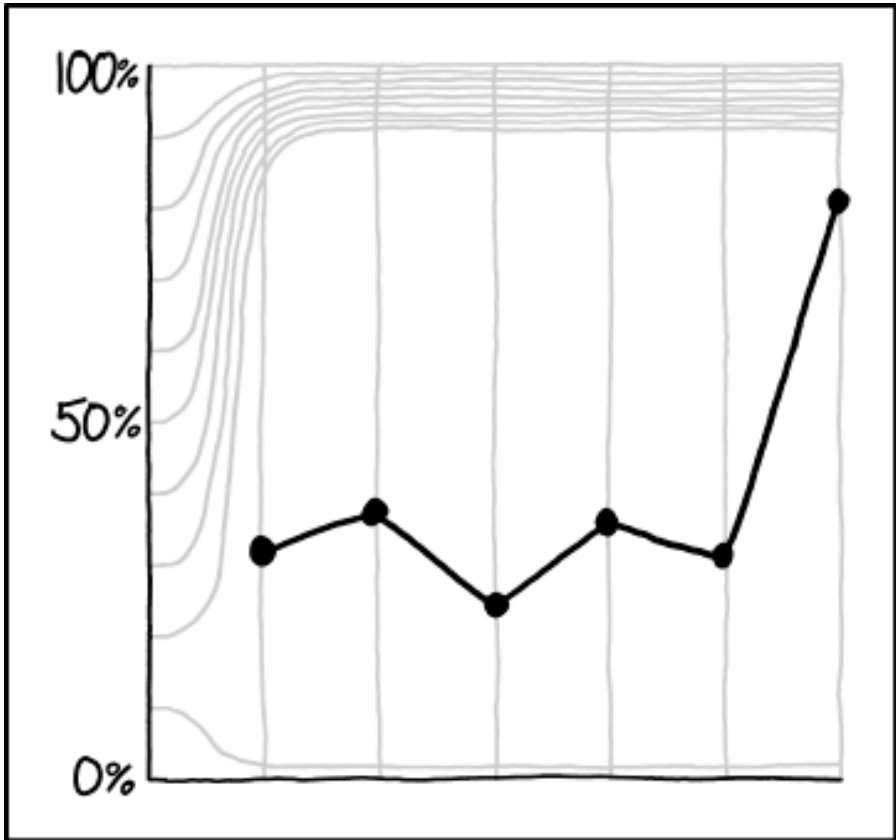
Explanation

In an example of nominative determinism, the comic lists people whose surname relates to their participation in various sports. It is presented as though it was created in the far future, reflecting on champions over the decades through to the 2080s. The first three are real sportspeople, the remainder are imaginary players of the future. The names progress from real, to fictional-but-plausible, to rare or highly unusual, to utterly implausible and impractical names.

Every caricature participates in their sport, except for Jebediah, who is standing at a lectern.

#2023: Y-Axis

July 23, 2018



PEOPLE HAVE WISED UP TO THE "CAREFULLY CHOSEN Y-AXIS RANGE" TRICK, SO WE MISLEADING GRAPH MAKERS HAVE HAD TO GET CREATIVE.

We've also developed the semi-semi-log scale, where the Y-axis for the left half of the graph is a log scale but on the right half it isn't.

Explanation

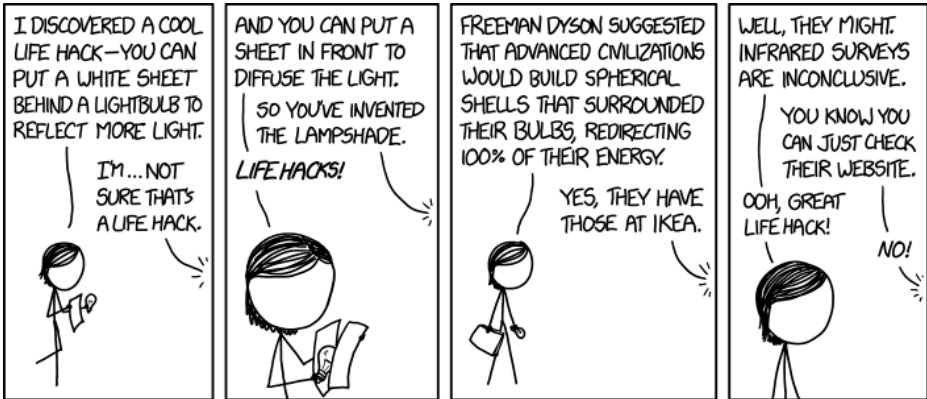
The comic itself makes a poke at recent trends where the y range for a given dataset is exaggerated, so that a dataset that varies very little in its y-values is exaggerated by constricting the y-axis of the graph to range from just barely below the minimum y-value to just barely above the maximum y-value. This spreads out the y-values so very small differences appear larger and more significant than they really are.

The graph shows an attempt to mislead readers by manipulating the y-axis scale of the graph in a creative manner: The y-axis labels at the left side of the graph are normally spaced; however, the thin, gray gridlines marking each 10% increment are wavy, not straight, and they bunch up before reaching the first data point, resulting in a distorted effective y-axis for the rest of the graph. All the data points lie between the 10% and 20% gridlines, but a casual reader may not notice this and think that the graph uses the full 0% to 100% range.

The title text refers to the Semi-log plot, where one of the two axes is plotted on a logarithmic scale. The title text takes this to a further extreme with the semi-semi-log, where the y-axis labels are only interpreted as logarithmic on the left half of the graph. (For example, on the left half of the graph "3" would be interpreted as 10^3 , or 1000, but on the right half it would be interpreted as 3)

#2024: Light Hacks

July 25, 2018



Life hack: Wait for an advanced civilization to be briefly distracted, then sneak in and construct a slightly smaller Dyson sphere inside theirs.

Explanation

"Life hacking" is the practice of using common everyday items in novel ways to increase the convenience or enjoyment of daily activities. This comic pokes fun at the many blogs and video channels that purport to cover life hacking tips, but merely point out obvious or intended uses for products or well known techniques as low effort clickbait.

Megan tells someone off panel that, by using sheets of paper, she can reflect and diffuse the light coming from a lightbulb. She refers to her discovery as a life hack, while the person off-panel sarcastically points out that all she has done is reinvent the lampshade, to which Megan again refers to as a life hack.

A Dyson sphere is a hypothetical energy-collecting megastructure encompassing a star, and collecting a large percent of its energy in the process. It is named after the physicist and mathematician Freeman Dyson.

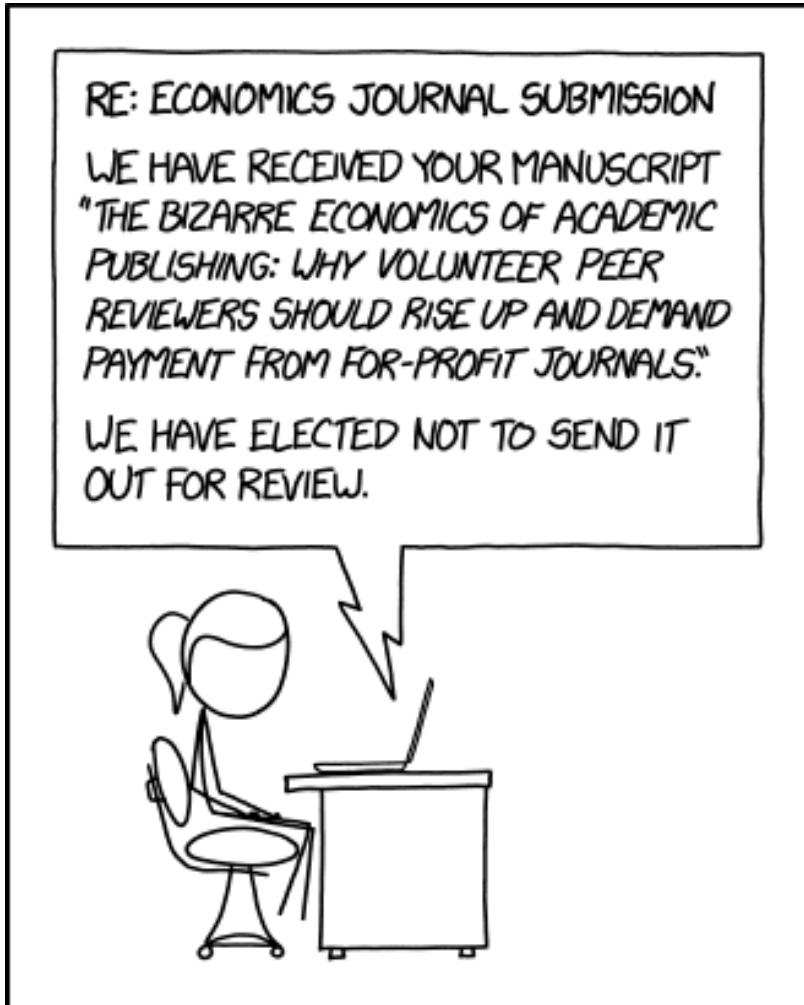
The joke here is that Dyson spheres are generally not intended for lightbulbs,[citation needed] yet using them in this way is suggested by Megan as a life hack, poking fun at the fact that life hacks make things more complicated instead of convenient. Freeman Dyson argued that Dyson spheres, if they existed, could be found by infrared surveys, as large objects that would emit infrared radiation. IKEA pendant lampshades are spherical shells that surround the bulb. Megan claims

studies have tried to use infrared surveys to find Dyson spheres at Ikea locations, without success. When the other person tells her the easier way, searching for it online, she eagerly refers to his method as another life hack, much to the other person's annoyance.

The title text creates a different sort of confusion of the term lifehack, with another sort of popular clickbait videos. Described activity, if done, would be considered a prank - depriving the distractible civilization of their sunlight and energy source, while redirecting the energy to Earth.

#2025: Peer Review

July 27, 2018



Your manuscript "Don't Pay \$25 to Access Any of the Articles in this Journal: A Review of Preprint Repositories and Author Willingness to Email PDF Copies for Free" has also been rejected, but nice try.

Explanation

When a researcher wants to publish their findings, they send it to an academic journal. The editor of the journal is another researcher (usually a college professor), who gets paid nothing or a minimal honorarium for editing the journal. The editor chooses a few (usually three) peer reviewers who are other researchers familiar enough with the study's subfield to judge the study's quality fairly and accurately, and sends it out to them for review. These peer reviewers do not get paid for the work of reviewing the manuscript and offering a detailed critique of every part of the study, from literature review to methodology to conclusions drawn from the results. If the peer reviewers and editor agree that the study was well-conducted and the paper well-written (or just needs minor revisions), it is accepted and published in the journal. The researcher is not paid for getting their paper published in the journal.

In short, nobody in the process is paid for their work except the journal publisher, who charges other researchers, libraries and individuals for access to the fruit of these people's free labor. This is commonly referred to as a "paywall".

This system relies upon researchers to be employed by either companies or universities in positions which require them to publish in order to remain employed or achieve promotions or pay raises. In universities, only postdocs and tenure-track or tenured professors are paid

in a way that figures in their research time as well as their teaching time, which means that anyone not in one of those positions (lecturers, educators, adjunct instructors) is not paid for any research they might be doing and publishing, nor are those who are conducting research but cannot get a tenure-track job due to universities replacing tenure lines with non-tenure-track positions.

Charging for access to these works has raised controversy in recent years, due to concerns that this may lead to information silos.

Ponytail seems to be presenting papers concluding that this flow of currency is not equitable. Unfortunately, the journal she has submitted these findings to has opted not to review or publish them, likely because they have a financial interest that conflicts with the publishing of her findings, since sending her paper to review would reach her target audience of voluntary peer reviewers and could potentially incite them to go on strike and demand payment for their work.

Furthermore, the comic contains the joke that Ponytail is doing exactly what she is dis-encouraging in the paper: publishing it in a journal, which probably does not pay their reviewers and possibly locks the papers behind a paywall. However, as this is how science works at the moment, she is obliged to do so in order to reach her audience.

The title text refers to a Twitter post that went viral. Researcher Dr. Holly Witteman informs the public that

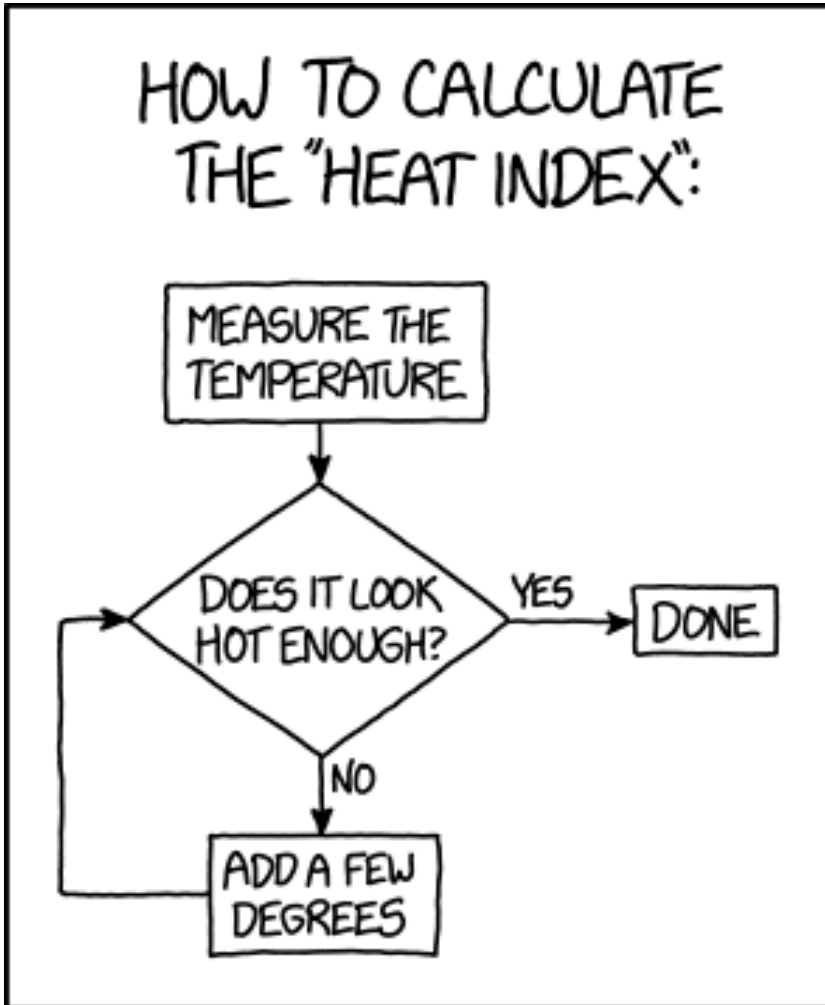
you could just ask many researchers for a PDF copy of their academic paper and that they would be delighted to do so free of charge. (This harkens back to the days of snailmail, when researchers would distribute printed copies, "reprints", of their work for, at most, the price of a self-addressed stamped envelope.) She has additionally written an article on the situation and how to get papers for free.

Pre-print repositories, such as arXiv, are online databases for researchers to publish drafts of their research for quick distribution to willing reviewers, sidestepping the lengthy and often arduous reviewing process as conducted by many research journals. These databases are free to access by researchers and the general public, and often papers will remain on these sites long after their journal publication, making them a convenient way to get to papers locked behind a paywall. However, the pre-print versions of the papers will often lack peer review, and as such may contain a higher occurrence of errors. There are also sites which collect and re-publish papers for free, such as Sci-Hub, which attempts to provide all published papers free of charge globally.

In the title text, the publisher refuses to publish a paper that describes ways to get around the paywall restrictions that make up their bottom line. In this refusal they even acknowledged that the author has tried to trick them, maybe by using one of those very long titles filled with incomprehensible jargon that is almost impossible to read, and remember to the end. So they finish the refusal by adding a "but nice try".

#2026: Heat Index

July 30, 2018



The heat index is calculated via looking up the "effective temperature" in a table of air temperature and humidity values, and then adding a bunch more degrees because it feels **WAY** hotter than that.

Explanation

Heat index, like wind chill, is a way to combine multiple factors, in this case temperature and humidity, to get a single number indicating what the air "feels like." This page gives a table, a formula, and lots more explanation.

Human skin does not directly detect temperature - only the rate of heat gain or loss. If you put pieces of metal, wood, and plastic at the same room temperature (cooler than the human body) the piece of metal feels cooler to the touch than a piece of plastic or wood - the metal conducts heat away from the higher body temperature at a higher rate than a good insulator does.

So in warm weather, it's not just the temperature that matters for comfort. The humidity and wind speed also factor into it. When humidity is high, sweat evaporation is less effective at cooling us off than in a "dry heat" with low humidity.

Hence, meteorologists use a combination of temperature and humidity to come up with the "heat index" value...and a combination of temperature and wind speed to produce a "wind chill" number.

Neither scale is particularly scientific in terms of measuring how people feel - but both are a more accurate representation of comfort levels than temperature alone.

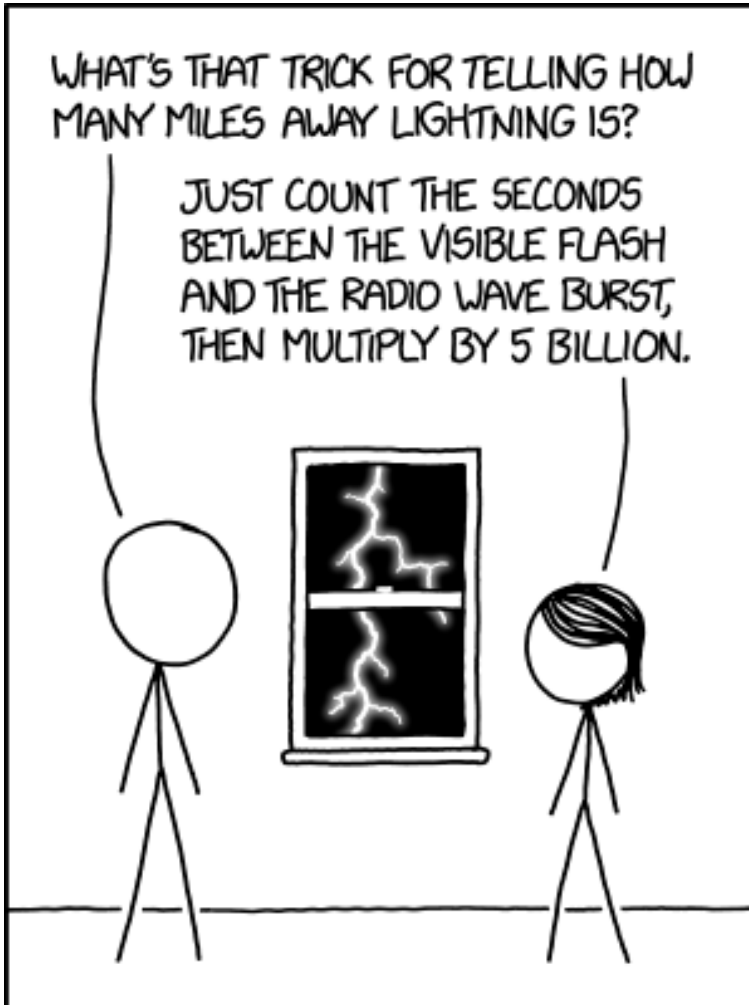
The joke here is that these numbers seem entirely subjectively chosen - and in a sense, they really are,

although they are calculated from an actual formula (a multivariate fit to a mathematical model of the human body - with nine terms!) and not by guesswork as the flow chart implies.

The title text suggests another way it is calculated: In general the effective temperature is calculated based on the conductivity of heat based on humidity. This is a legitimate method of determining how hot something feels because the heat conductance of water is higher than dry air and humans perceive more heat when the humidity is higher. But humans also tend to exaggerate and so Randall implies to add still a bunch more to satisfy the subjective sentiment.

#2027: Lightning Distance

August 01, 2018



The index of radio refraction does have a lot of variation, which might throw off your calculations, so you can also look at the difference in brightness between the visible flash and more-attenuated **UV** and x-rays.

Explanation

The usual trick for determining the distance to a lightning flash is to count the seconds from when you see the flash until when you hear thunder, and divide by five to get miles (or three to get kilometers). This works because the transmission of light is essentially instantaneous over the relevant distances, while the speed of sound is 331.2 m/s (1,087 ft/s, 1,192 km/h, or 741 mph, varying a bit based on temperature), or about 1/5 mile per second (1/3 kilometer per second).

This comic subverts the usual trick by having Megan describe a highly impractical alternative method. Megan's method is based on the fact that the speed of electromagnetic radiation, which includes light and radio waves, is not truly fixed and varies by wavelength in a refractive medium (consider the classic case of visible light in a prism). The electromagnetic radiation emitted by lightning on Earth also has to travel through air, which changes its speed in a fashion which depends on its frequency.

Lightning is most visibly observable in the near-infrared visible spectrum around a wavelength of 777 nm. The refractive index (n) of air at 15°C for a wavelength of 777 nm is 1.0002752, which equates to a speed of light of 299,709,978 m/s given the relation $n=c/v$, where c =speed of light in a vacuum and v =the velocity of light in the medium.

Terrestrial lightning generates very-low-frequency radio waves ranging in frequency from 1 kHz to 30 kHz known as whistlers from bouncing off the ionosphere, and wider-band emissions known as sferics. Much of this would exist in the very low frequency category of radio waves, for which literature values of refractive index is harder to determine. Using the formula given in this paper, the refractive index for radio waves in similar conditions is 1.000315, which equates to a speed of light of 299698.0 km/s (or 186223.7 miles/s). This means that to get the distance in kilometers, the time difference between flash and radio burst should instead be multiplied by 13.6 billion (or 8.45 billion for miles).

Using a setup similar to that used for passive radar, it would theoretically be possible to use this effect to determine the distance to a source of extremely short bursts of visible light and radio waves, although one might have to compensate for the tiny effect time with tricks involving phase detection or receiver harmonics. Large inaccuracies may propagate from the inconsistency of air pressure, temperature, electron density, humidity in the atmosphere, even local temperature of the receiver, which may need to be taken into account.

The joke is that it is impractical for people who haven't spent time with radio engineering, because they haven't heard of measuring such small time intervals (on the scale of 0.1 nanoseconds per kilometer or mile) and because they don't know how to detect radiation outside the visible spectrum, which can be done with a \$20 radio dongle. An upconverter may be needed to measure the

low-frequency details, and possibly building one's own loop antenna to pick them up in the first place. It would be difficult to use such a "rule of thumb" for somebody not already exposed to either the amateur software-defined-radio scene or professional hardware.

Although lightning lasts about 60 to 70 microseconds, during which time the signals we receive would rise and fall somewhat erratically, a software-defined radio can sample the phase and strength of the signal in detail during this time and provide a record of it for comparison with a recording at a different frequency. A more expensive radio would make life easier, as a sampling rate of at least a few GHz would allow for the time discrepancy to be measured directly using the onset of the signal, rather than possibly inferred from phase differences at different frequencies.

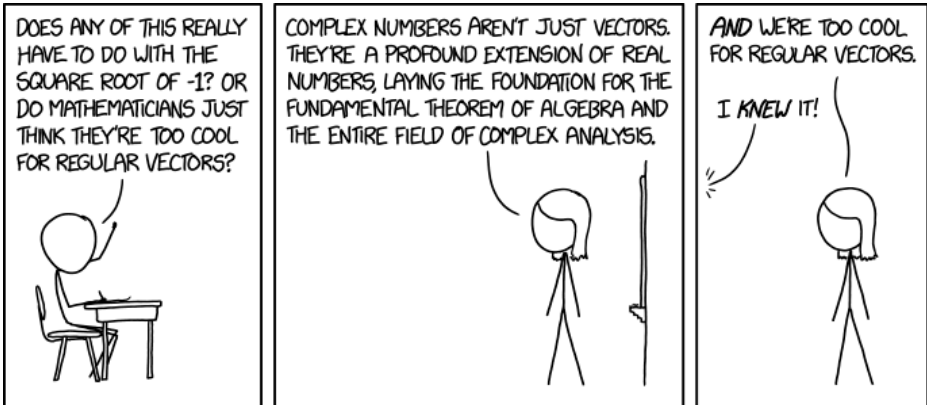
For the purpose of the joke, the "5 billion" value used in the comic is a fair estimate which also references the original rule of 5 seconds per mile nicely, though the result can have a huge margin of error depending on actual conditions (temperature, humidity, etc.), as the title text suggests ("the index of radio refraction does have a lot of variation").

The title text suggests another method of calculating the distance to lightning. Since the absorption of light is also different in different wavelengths, it would be possible to calculate the difference by comparing the brightness instead of relative delay. This would, however, require the knowledge of the emission spectrum of lightning and

attenuation ratios of different wavelengths (which would both vary across conditions).

#2028: Complex Numbers

August 03, 2018



I'm trying to prove that mathematics forms a meta-abelian group, which would finally confirm my suspicions that algebraic geometry and geometric algebra are the same thing.

Explanation

The complex numbers can be thought of as pairs of real numbers with rules for addition and multiplication.

As such, they can be modeled as two-dimensional vectors, with standard vector addition and an interesting rule for multiplication. The justification for this rule is to consider a complex number as an expression of the form $a + bi$, where i , i.e. i is the square root of negative 1. Applying the common rules of algebra and the definition of i yields rules for addition and multiplication above.

Regular two-dimensional vectors are pairs of values, with the same rule for addition, and no rule for multiplication.

The usual way to introduce complex numbers is by starting with i and deducing the rules for addition and multiplication, but Cueball is correct to say that some uses of complex numbers could be modeled with vectors alone, without consideration of the square root of a negative number.

The teacher, Miss Lenhart, counters that to ignore the natural construction of the complex numbers would hide the relevance of the fundamental theorem of algebra (Every polynomial of degree n has exactly n roots, when counted according to multiplicity) and much of complex analysis (calculus with complex numbers; the study of analytic and meromorphic functions), but she also agrees

that mathematicians are too cool for "regular vectors." Just because the complex numbers can be interpreted through vector space, however, that doesn't mean that they are just vectors, any more than being able to construct the natural numbers from set logic mean that natural numbers are really just sets.

In mathematics, a group is the pairing of a binary operation (say, multiplication) with the set of numbers that operation can be used on (say, the real numbers), such that you can describe the properties of the operation by its corresponding group. An Abelian group is one where the operation is commutative, that is, where the terms of the operation can be exchanged: . The title text argues that the "link" between algebra and geometry in "algebraic geometry" and "geometric algebra" is the operation in an Abelian group, such that both of those fields are equivalent. Algebraic geometry and geometric algebra are mostly unrelated areas of study in mathematics. Algebraic geometry studies the properties of sets of zeros of polynomials. It runs relatively deep. Its tools were used for example in Andrew Wiles' celebrated proof of Fermat's Last Theorem. For its part, a geometric algebra (a Clifford algebra with some specific properties) is a construct allowing one to do algebraic manipulation of geometric objects (e.g., vectors, planes, spheres, etc.) in an arbitrary space that has a resultant geometric interpretation (e.g., rotation, displacement, etc.). The algebra of quaternions, which is often used to handle rotations in 3D computer graphics, is an example of geometric algebra, as is the algebra of complex

numbers. Meta-Abelian groups (often contracted to metabelian groups) is a class of groups that are not quite abelian, but close to being so.

Randall's joke in the title text is a wordplay combining the concepts of (meta-)abelian groups and change in the order of word orders with the general idea of "meta".

This comic is similar to the earlier Miss Lenhart comic 1724: Proofs.

#2029: Disaster Movie

August 06, 2018

THE LAVA IS ENTERING THE SEA, AND
NEW RIFTS ARE OPENING TO THE NORTH!

GET A GIS SURVEY TEAM IN
THE AIR! WE NEED TO REVISE
OUR COASTLINE SHAPEFILES!



I WANT TO MAKE A DISASTER MOVIE
THAT JUST SHOWS SCIENTISTS RUSHING
TO UPDATE ALL THEIR DATA SETS.

Really, they'd be rushing around collecting revisions to go into the next scheduled quarterly public data update, not publishing them immediately, but you have to embellish things a little for Hollywood.

Explanation

Disaster movies are a sub-genre of movies, which resolve around a disaster, such as a natural disaster, worldwide disease pandemic or an attack. Typically, the plot of a disaster movie is how the main characters escape the disaster, avert its climax or deal with the aftermath of the disaster. Here, Randall has subverted this plot device by showing Ponytail call for a GIS survey team to map out the result of the disaster. Instead of panicking for survival, the scientists are rushing to update their data sets, similarly to in 2098: Magnetic Pole.

"Lava entering the sea, and new rifts opening to the north" may be a reference to the 2018 lower Puna eruption, a volcanic event on the island of Hawaii. Due to this eruption event, lava did enter the Pacific Ocean. As of the time of publishing, this event was still occurring.

GIS ("geographic information system") is a computer system that stores and analyses spatial and geographic data, and by extension, the profession of experts who use computers to make maps and perform spatial analysis.

Presumably, a "GIS survey team" would go above the affected area in a helicopter, mapping the coastline changes caused by the natural disaster. A "GIS survey team" presumably means a team of geographic surveyors. However, surveying is usually carried out on the ground, and surveying is not usually considered part of GIS. Also,

these days, satellite imagery is usually used for this purpose, as there are several companies that can provide imagery refreshed as often as every day. Finally, a "GIS survey team" would most likely be one of many companies that provides these kinds of services, not "scientists", as suggested in the caption. An example of this is an ArcGIS map of the mentioned 2018 lower Puna eruption.

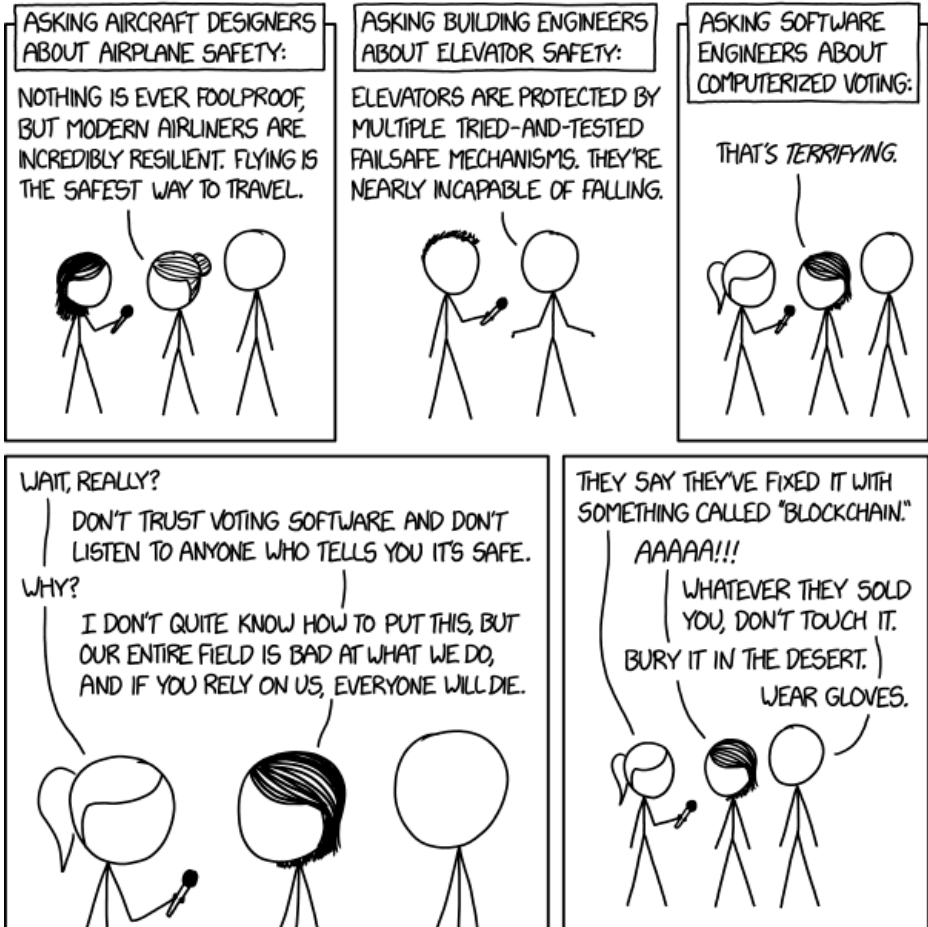
A Shapefile is a proprietary data format for spatial data which remains in widespread use, despite being created in the early 90s, and based on an even older database format. Amongst non-GIS people "shapefile" is often used synonymously with "geographic data", regardless of the actual file format. "Our coastline shapefiles" then means "our geographic data for the coastlines", although such data would most likely be stored in a database, not a Shapefile.

The situation described (scrambling to update geographical datasets in the advent of natural disaster) is actually a common occurrence these days. The Humanitarian OpenStreetMap Team's Disaster Response unit does almost exactly this: When there is a natural disaster in a location that lacks high quality GIS data (common in much of the developing world), a team of volunteers across the world mobilizes to update and improve OpenStreetMap. They use the latest available satellite imagery, usually donated free for the purpose. Disaster response teams then use the GIS data in OpenStreetMap to create maps and plan their response.

The title text refers to the fact that most GIS datasets are not published in "real time", but, rather in updates every 3 months or less often. This is due to the many manual steps still present in many GIS publishing and consuming workflows, which preclude more frequent schedules. Thus, there is not as much of a rush to do their updates, and the need is not as urgent as the proposed film would show. Randall claims the urgency was exaggerated for dramatic effect, humorously disregarding the fact that neither version of this scene would be dramatic to a typical moviegoer.

#2030: Voting Software

August 08, 2018



There are lots of very smart people doing fascinating work on cryptographic voting protocols. We should be funding and encouraging them, and doing all our elections with paper ballots until everyone currently working in that field has retired.

Explanation

This comic is a commentary on voting machines specifically, and more generally the contrast between what experts will trust and what the average user will trust.

The first two panels of this comic involve a reporter talking to professional mechanical engineers, asking about the given safety of the products/solutions that each of their fields help to produce (airplanes from aircraft designers in panel 1, elevators from building engineers in panel 2). While the two inventions selected are relatively new when compared to how long humans have existed, the two fields mentioned have existed for multiple human generations, giving enough time to find flaws in their products/solutions and solve said flaws to the point that they can be considered safe for the general public to use.

The comic from panel 3 onwards contrasts this with computer engineers Megan and Cueball, both agreeing that their given field (computer science/software development/software engineering) does not have the overall consistent competency that other fields have (or at least appear to have). Indeed, at least anecdotally there are very few ethical and security restrictions for what developers can/cannot do, and relatively minor consequences when catastrophes arise from poor decisions.

When the reporter follows the interview up with a mention of blockchain technology, Megan and Cueball reflexively tell the reporter to avoid any voting system using the technology at all costs. Blockchain is a relatively new technology that is intended to solve some computer security issues by making it difficult to doctor old data. However, in the process of solving the old computer security issues, it has introduced new computer security issues that have not yet been ironed out; for instance, it doesn't solve input fraud issues, only data-doctoring fraud, so if a program caused the voting machine to record a vote for candidate B whenever a vote for candidate A was cast (such a program could be uploaded to the voting machines through USB, or through the internet which the voting machine must be connected to for blockchain), blockchain would not prevent it. Blockchain has also had a large number of high-profile scams, thefts, and implementations with critical security holes. Thus, Megan and Cueball may not trust this blockchain solution because of this history.

The title text confirms the comic's stance by implicitly saying that any digital voting systems are to not be used under any circumstances. It may also highlight that anyone working in the field is vulnerable to corruption, or at least that the field is far from maturity. Humorously the title text says digital voting systems should still be developed, but mostly to keep the people who want to use them occupied, rather than allowing them to actually publish their work in the real world where it can cause serious harm.

Computer systems, operating primarily in a digital domain, fail differently from most traditional areas of engineering, which operate in analog (or continuous) domains. A small error in an analog part often gives a result which is close to the desired properties (it almost fits, it works most of the time). By contrast, a small error in a digital system (just one bit being changed) can easily make the system function in radically different ways (if not just crash entirely). So not only is software engineering younger than other areas of engineering, but the domain is much less forgiving. Even small errors/variations produce catastrophe down the line.

This fear of computerized voting is a result of a fundamental difference between computer security and other types of safety measures: Most engineers only have to deal with wear and tear, and very rarely have to guard against sabotage. In contrast, in cryptography there is always somebody trying to undo what you've built. Not only that, but new advances in cryptography tend to point out vulnerabilities with previous versions, making them not only obsolete, but dangerously so. For these reasons, it is especially important to make sure that whoever is selling you the security method is both competent and non-malicious, but because crypto software is highly technical and often confidential/proprietary, it can be hard to verify this if you're not an expert in the field (which you won't be, if you're buying it).

These issues are especially pertinent to voting machines, which store incredibly sensitive information but are

often catastrophically outdated due to lack of funding. There are also major issues with electronic voting in general; for example, this video from Computerphile raises issues of malware infections, transferring the votes to the election authorities without having them intercepted, and needing to trust both the machine's software and central counting system to present an accurate account of the votes. Furthermore, the people purchasing them, the politicians, are generally not known for their technical understanding -- or their impartiality.

Interestingly, this comic was posted a day before DEF CON 2018, and it was shown there that the voting systems that will be used across America for the mid-term vote in November are, in many cases, extremely insecure. The topic of voting machines has been covered before in 463: Voting Machines, where the use of anti-virus software on the machines has been discussed.

Blockchain[edit]

The way blockchain works is that several computers have data being inputted into them. With each tick, they all share their current states with each other, and encrypt and hash it. That state then becomes a 'block' in the chain. They then share states, including that block as part of the state, then hash and encrypt it, and then it becomes a 'block' in the chain. Each 'block' is included in the cryptographic hash of all following blocks, so if a change is made to any given block, all blocks after that block must be changed.

Due to the distributed nature, if changes are made to any chain, it can be compared against the other chains, and so long as the majority say that the changes didn't happen, it's reverted and removed. However, the point of decentralization is to avoid dependence on a single, central authority. But in the case of voting, there's a single, central authority at the precinct, county, or state level, so using a blockchain would be needlessly complex, add extra computers that could be subverted, require an internet connect (most voting machines are deliberately not connected to the Internet for security purposes), and so on.

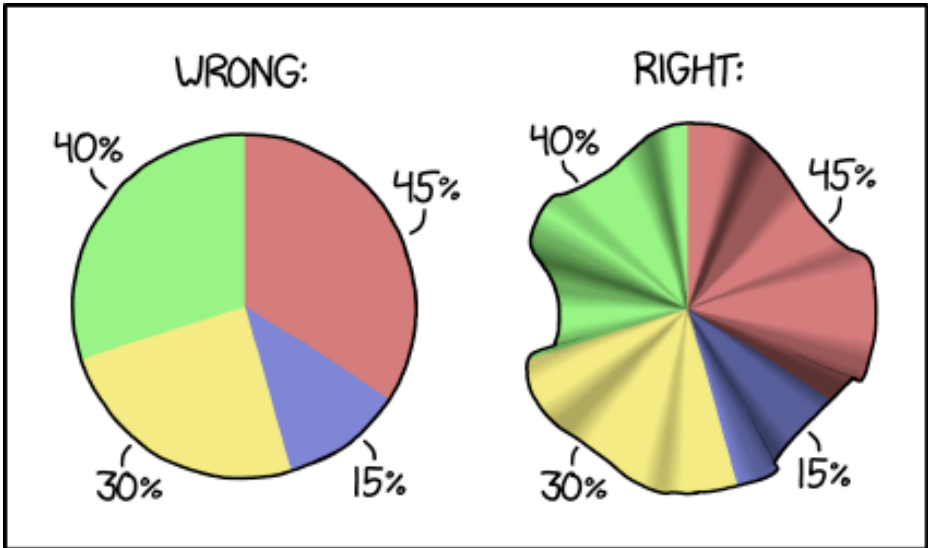
Blockchain is really great at preventing post-facto data changes. With blockchain you can somewhat guarantee that no one comes in after the election and changes the votes on the machines. (Unless they're handling the blockchain in a stupid fashion, for example without the distribution.) But you cannot prevent tampering with the machines themselves, such as making them record votes that didn't happen, or tampering the data before it's written to the blockchain.

Also, the security issues that Blockchain solves could also be solved via write-once memory, which would be more secure and more difficult to doctor.

Most computer security specialists are more worried about programs that randomly and/or deliberately misreport a vote, than people changing the votes after they're already recorded, so blockchain would solve an issue that most computer security specialists are less worried about, while causing new issues (the perpetual internet connection among them).

#2031: Pie Charts

August 10, 2018



HOW TO MAKE A PIE CHART IF YOUR PERCENTAGES DON'T ADD UP TO 100

If you can't get your graphing tool to do the shading, just add some clip art of cosmologists discussing the unusual curvature of space in the area.

Explanation

Pie Charts graph proportions as "slices" of a circle, like a pie that you cut into slices. The circle, or Pie, represents the whole sum of the slices, or 100% of the data. As such, if the data represented by the slices is expressed as percentages, the total of all the slices, by definition, must total 100%. This comic introduces a new technique for getting around that rule by "warping" the circle to allow more than 100% of the data to exist in the graph. Thus the total amount of 130% is represented with a shape that bends out of plane in order to fit a 30% larger area into the footprint of a circle.

This shape does not aid in understanding the figures. At best, it serves to highlight a methodical error. Pie charts are intended to represent nonoverlapping fractions of a whole. If the entire pie does not represent the whole, and each sector a disjoint piece, then the pie chart is misleading and may be impossible to draw. A different type of chart should be used.

Percentages that add up to more than 100% are often a sign that a math error has occurred, whether a typo somewhere or a sloppy case of taking numbers from different sources. However, they can arise naturally in cases where each item can belong to more than one group, such as approval voting (40% of the people like green 45% like red etc., however there may be some that like both green and red). In such cases, a more accurate depiction would have some form of overlap of the pie

pieces, not a warping of the space which they occupy. For instance, for 2 colors, Red and Green, the pie chart could have four sectors: approval of both R and G, of just R, of just G, and of neither R nor G. These will necessarily add to 100%, since they exhaust all logical possibilities. If this is impossible or confusing, a completely different representation should be used, such as a bar chart. An exception can occur if the percentages of the pieces have been rounded for readability—the percentages do indeed sum to 100, but after they are each rounded individually, the rounded numbers can sum to a slightly different value. This is still appropriate for a pie chart, and when charts like this are published, a small notice is sometimes published beneath it explaining the discrepancy due to rounding. If each group is rounded to the nearest 1%, with 0.5 rounded up, then the maximum possible sum of rounded percentages is $(100 + n/2)\%$, where n is the number of groups and \cdot is the floor function. For instance, with groups of size 0.5%, 0.5%, 0.5%, and 98.5%, they would round up to 1%, 1%, 1%, and 99%, for a sum of $102\% = (100 + 4/2)\%$.

Percentages don't need to add up to 100% to be correct. For example, if ten people wear blue t-shirts and ten wear red t-shirts, then 50% of them wear each color for a total of 100%. Now if one of each joins the group, 55% of the original population wears each color, for a total of 110%, as the total population risen by 10%. That said, this change should be represented by something like a bar graph, not by pie chart. If percentages are represented by a pie chart, the assumption is that the total should be

100%, independently of the math behind it.

In this case, the right image appears to be what happens when you cut the pie chart segments out of fabric, stitch them together, and let the resultant fabric flop around a bit.

The title text presents an alternative if shading is not possible, namely to excuse the percentage inaccuracy with scientists discussing curvature of space.

#2032: Word Puzzles

August 13, 2018



MY HOBBY: MESSING WITH WORD GAME
ENTHUSIASTS BY USING WORDS THAT MAKE
THEM ~~SURE~~ THERE'S A PUZZLE TO SOLVE

Eno's storied aria was once soloed by Judge Lance Ito on the alto oboe at Ohio's AirAsia Arena.

Explanation

This is another comic in the "My Hobby" series, where Randall presents his hobby of fooling other people. This particular hobby seems to be a case of Nerd Sniping, similar to that in 559: No Pun Intended. Cueball knows that Megan is a word game enthusiast and - while both are probably at a party - he presents a complex sentence rather than just doing small talk. He is successful, as we can see that she is just thinking about the proper solution to that puzzle, which probably doesn't exist.[citation needed]

The dialog, caption, and title text contain many words that appear frequently in crossword puzzle answers because they fit well with intersecting words, in part because they have a high density of vowels. Some of the terms (parts of, start of) are also commonly used in cryptic crossword clues to indicate that nearby words should be combined or split to create an answer.

Brian Eno is an English musician, composer, record producer, singer, writer, and visual artist. He is best known for his pioneering work in ambient music and contributions to rock, pop, electronic, and generative music. He was born on 15 May 1948, and is still an active artist. But live concerts by him were rare and may not happen ever again. However, the aria was not written by himself but by his au pair who is also an opera star. And this happened after Eno ended his live career.

The title text goes further on this puzzle and asserts that Lance Ito was playing the aria solo on an oboe at the fictive AirAsia Arena in Ohio. Ito is well known as the judge in the O. J. Simpson murder case.

The kind of puzzle that Megan thinks she is solving is called a "Cryptic" or cryptic crossword, which has markedly different rules than ordinary crosswords. If Cueball's statement had been "Part of this aria is an Indian garment" the answer would have been "sari", because a part of the phrase "this aria" is the sequence "sari", which in turn is an Indian garment. Cueball's actual statement contains quite a few familiar cryptic puzzle triggers. The word "composed" can be a hint of a preceding or following anagram, in this case of "this aria" or of "by Brian" or of even longer adjacent strings. Although "opera star" could be a famous singer, say "Caruso", it might also be the name of an opera followed by the name of an astronomical star. "Au pair" could be any of its ordinary meanings, say "nanny", but might also be "earrings" (because Au is the chemical symbol for gold, and a gold pair could be earrings). The word "start" is often a hint to take just the beginning of a word, so "the start" would be "t", or "start of his" would be "h" or (less commonly) "hi". The New York Times runs a cryptic crossword as its "second Sunday puzzle" every other month or so, and there are other regular cryptic crossword venues.

There are various guides on the web for solving cryptics, such as this one at The Atlantic: [Puzzler Instructions](#). Recently, information on cryptic crosswords even got its

own wiki.

#2033: Repair or Replace

August 15, 2018



I'M SURE THE ECONOMICS MAKE SENSE,
BUT IT STILL FREAKS ME OUT HOW QUICK
COMPANIES ARE TO REPLACE COMPUTING
DEVICES INSTEAD OF TRYING TO FIX THEM.

Just make sure all your friends and family are out of the car, or that you've made backup friends and family at home.

Explanation

This comic compares the repair of cars with that of computers or other similar electronic devices. The question Repair or Replace? comes up more frequently with electronics than with cars, hence the title of the comic, and the humor derived.

Cueball is in his car. He says that there is a weird sound and asks if the car mechanic Hairy will take a look. Hairy asks him to open the car's hood, exposing the engine, to further identify the cause of the problem. Cueball then says that his hood latch, the lever used to open the hood, is also broken. The solution, according to Hairy, is then to discard the car, and "replace" it with a new car.

In reality, fixing the latch on the hood is a simple task for a skilled mechanic and would not justify writing-off the car. When a car is malfunctioning, the usual response is to attempt to repair it. A car is designed so that many of the parts can be replaced or adjusted. By contrast, when a computer or electronic device is malfunctioning, it is often judged to be more expensive to repair than to replace, and the usual action is to purchase a new device. It is generally possible to replace each part of a desktop or laptop computer, but harder to do so for more integrated devices such as tablets, and almost impossible to repair individual components with faulty or damaged integrated circuits. Thus, Randall notes in this comic that while it does make sense for electronic devices, the "solution" of replacing an object instead of attempting to

repair seems absurd for many other expensive items.

The title text refers to data stored on a computer or electronic device. Before replacing the device, it is recommended backup all your personal files, so that you have future access to them, and to remove them for security. Randall likens this to having your friends and family exit the vehicle, or making backup friends and family before the vehicle is thrown away.

This comic is similar to 1737: Datacenter Scale, which is also about discarding servers instead of fixing them.

#2034: Equations

August 17, 2018

$$E = K_0 t + \frac{1}{2} \rho v t^2$$

ALL KINEMATICS
EQUATIONS

$$K_n = \sum_{i=0}^{\infty} \sum_{\pi=0}^{\infty} (n - \pi) (i + e^{\pi - \infty})$$

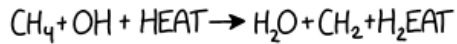
ALL NUMBER
THEORY EQUATIONS

$$\frac{\partial}{\partial t} \nabla \cdot \rho = \frac{8}{23} \oint \rho ds dt \cdot \rho \frac{\partial}{\partial \nabla}$$

ALL FLUID DYNAMICS
EQUATIONS

$$|\psi_{x,y}\rangle = A(\psi) A(|x\rangle \otimes |y\rangle)$$

ALL QUANTUM
MECHANICS EQUATIONS



ALL CHEMISTRY
EQUATIONS

$$\text{SU}(2) \text{U}(1) \times \text{SU}(\text{U}(2))$$

ALL QUANTUM
GRAVITY EQUATIONS

$$S_g = \frac{-1}{2\epsilon} i \delta \left(\hat{\xi}_0 + p_i p_v^{abc} \cdot \hat{\eta}_a \right) F_a^\alpha \lambda(\xi) \psi(0_a)$$

ALL GAUGE THEORY
EQUATIONS

$$H(t) + \Omega + G \cdot \Lambda \dots \begin{cases} \dots > 0 & (\text{HUBBLE MODEL}) \\ \dots = 0 & (\text{FLAT SPHERE MODEL}) \\ \dots < 0 & (\text{BRIGHT DARK MATTER MODEL}) \end{cases}$$

ALL COSMOLOGY EQUATIONS

$$\hat{H} - \psi_0 = 0$$

ALL TRULY DEEP
PHYSICS EQUATIONS

All electromagnetic equations: The same as all fluid dynamics equations, but with the 8 and 23 replaced with the permittivity and permeability of free space, respectively.

Explanation

This comic gives a set of mock equations. To anyone not familiar with the field in question they look pretty similar to what you might find in research papers or on the relevant Wikipedia pages. Most of the jokes are related to the symbols or "look" of most equations in the given field.

The comic makes jokes about the fields of kinematics, number theory, fluid dynamics, quantum mechanics, chemistry, quantum gravity, gauge theory, cosmology, and physics equations. Of course, all of the equations listed are not real equations (and H2EAT are clearly jokes and making a mockery of the given field). As always, Randall is just having a laugh.

Most kinematics equations are polynomials, usually at most quadratic, and are often integral quantities (corresponding to the $\frac{1}{2} t^2$ term). This specific equation resembles the actual kinematics equation $d = vt + \frac{1}{2}at^2$, but replaces a (acceleration) with v (velocity) times (density) and replaces velocity with "K0", which is not a term used in kinematics.

Number theory is the study of the integers and their properties. Randall jokes about how this often involves the use of summations over integers. The subscripts are indices, but the use of π as a summation index is a joke — π is almost always used for the well-known constant 3.14159..., not a variable. The use of i as a summation

variable is common, but the joke is that when it appears along with the constant e , as it does here it usually represents the imaginary unit $\sqrt{-1}$. As well, the constant e is out-of-place in a field like number theory — it's more closely related to fields like calculus/analysis. The use of the symbol e as a literal is also a joke.

Fluid dynamics equations often involve copious use of vector calculus operators. It's common in field theories like fluid dynamics and electromagnetism to represent equations of motion using multidimensional operators, like the ∇ and closed contour integral which appear here. The fraction $8/23$ is a comically weird choice, but various unexpected fractions do pop up in fluid dynamics. The ds and dt go with the double contour integral (s is probably distance, t is time), but the derivative with respect to t at the end is very much a joke and not allowed.

Quantum mechanics often involves some of the foreign-looking symbols listed, including bra-ket notation, the tensor product, and the Greek letter Ψ for a quantum state. Specifically, the left side of the equation is a ket state labeled Ψ that depends on x and y (probably positions), while the right-hand side may be an operator A that depends on the state Ψ (it is very unusual to have such a dependence) acting on what looks like another copy of that operator which depends on the outer product of states labeled by x and y (again strange). A charitable interpretation could be that the second A is the eigenfunction A of the operator A . Normally this is clearly indicated by giving the operator a “hat” (\hat{A})

symbol) or making the eigenfunction into a ket eigenstate, but since the equation is intentionally nonsense both A's are left ambiguous. Also note that the bra-ket math is inconsistent here, as the left side is a ket, but the right side is just two A's, which are either operators or functions but are definitely not kets.

Chemistry equations use formulas of chemical compounds to describe a chemical reaction. Such equations show the starting chemicals on the left side and the resulting products on the right side, as displayed. Sometimes such an equation might optionally indicate that an activation energy is required, for the reaction to take place in a sensible timeframe, e.g. by heating. A reaction requiring heating is usually indicated by a Greek capital letter Delta (Δ) or a specified temperature above the reaction arrow, however this comic uses the "+ HEAT" term on the left side instead. The joke is that Randall interprets "HEAT" to be another chemical which reacts with Hydrogen (H) to H2EAT, which is nonsensical, as heat is transferred energy here, not added matter. Regardless of this, Randall gets the stoichiometry of this equation correct, with the same number of all types of 'atoms' on each side of the equation.

Quantum gravity uses mathematical groups denoted by uppercase letters, as shown. $SU(2)$, $U(1)$, and $U(2)$ are all well-studied groups, though ' $SU(U(2))$ ' makes no sense. The lack of relator means this expression isn't an equation, but an expression.

Gauge theory is a subset of quantum field theory.

Because the objects in gauge theory carry a lot of symmetry information, they tend to have a lot of indices and twiddly annotations. Shorthand, such as the Feynman slash, is also very common. Although most of the symbols used here do not have specific meanings in gauge theory, ξ corresponds to the R_ξ gauges in quantum electrodynamics, and the "abc" superscript is reminiscent of a structure constant.

Cosmology is the science of the development and ultimate fate of the universe. The joke here may be pertaining to the different models accepted in the field of cosmology. H is the Hubble parameter, Ω is the universal density parameter, G is the gravitational constant, and Λ is the cosmological constant.

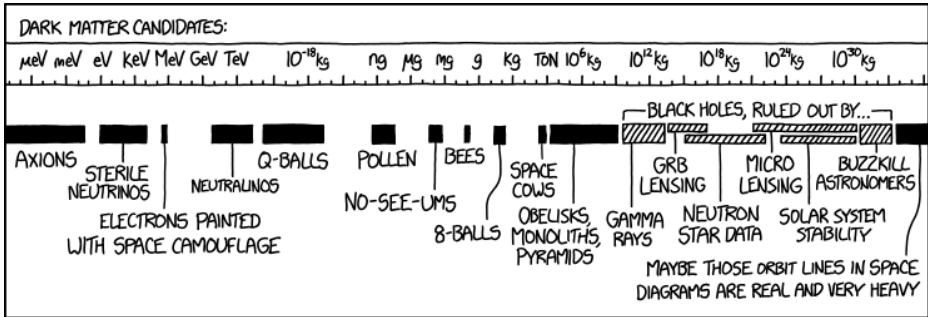
The joke about the "truly deep physics equations" is that most of the universal physics equations are simple, almost exceedingly so. In general, many of these equations are types of conservation law equations, which reflect some of the basic truths of the universe. A hallmark of conservation laws is that the total amount of some physical value does not change, and so one side of the equation is zero, as shown in the example. One example is Einstein's $E = mc^2$, which shows conservation of mass-energy. Noether's theorem shows that conservation laws have a one-to-one correspondence with a symmetry of nature, making these equations truly 'deep'.

The title text is referencing the fact that the electric and magnetic fields are often explained to physics students

using an analogy with fluid dynamics, as well as the fact that they do share some similarities (only in terms of mathematical description as three-dimensional vector fields) with fluids. The permittivity constant (represented with ϵ_0) and the permeability constant (represented with μ_0) are coefficients that relate the amount of charge required to cause a specific amount of electric flux in a vacuum and the ability of vacuum to support the formation of magnetic fields, respectively. They appear frequently in Maxwell's equations (the equations that define the electric and magnetic fields in classical mechanics), so Randall is making the joke that any surface integral with them in it automatically is an electromagnetism equation.

#2035: Dark Matter Candidates

August 20, 2018



My theory is that dark matter is actually just a thin patina of grime covering the whole universe, and we don't notice it because we haven't thoroughly cleaned the place in eons.

Explanation

Dark matter is a hypothetical, invisible form of matter used by the vast majority of astronomers to explain the far too high apparent mass of objects at large scales in our universe. In galaxies, stars are orbiting faster than the gravitational force of the sum of the masses of visible matter in the galaxy could cause, and entire galaxies are observed moving much faster around each other than their visible masses could explain. In galactic collisions, the mass can appear to separate from the visible matter, as if the mass doesn't collide but the visible matter does. A small handful of galaxies have been observed to not have this property, suggesting that it is a thing that a galaxy can have more or less of and is separable from. At scales of our solar system, those effects are too small and can't be measured. The most plausible explanation for all of these phenomena is that there is some "dark matter" that has gravity, but is otherwise undetectable. In cosmology, dark matter is estimated to account for 85% of the total matter in the universe.

This comic gives a set of possibilities for what dark matter could possibly be, charted by mass from smallest (given in electronvolts) to largest (given in kilograms). Masses in the range 10^{-15} to 10^{-3} kg are given in grams together with appropriate prefixes, while the ton takes the place of 10^3 kg.

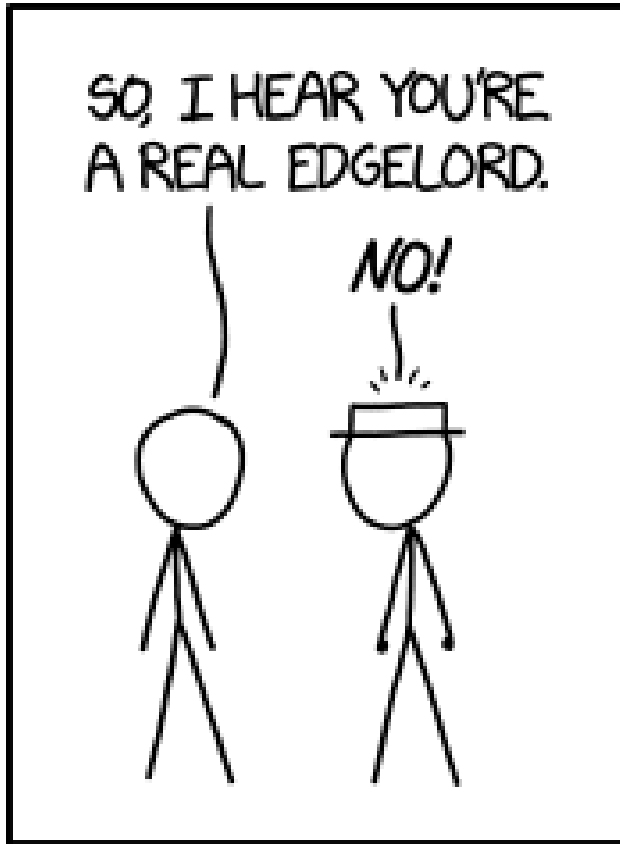
Only massive objects ranging from subatomic particles up to super massive ones are covered in this comic. There

are also alternative hypotheses trying to modify general relativity with no need of additional matter. The problem is that these theories can't explain all different observations at once. Nonetheless dark matter is a mystery because no serious candidate has been found yet.

The joke in this comic is that the range of the mass of the possible particles and objects stretch over 81 powers of ten, with explanations suggested by astronomers covering only some portions of that range. Randall fills the gaps with highly absurd suggestions.

#2036: Edgelord

August 22, 2018



HOW TO ANNOY A GRAPH THEORY PH.D.

If you study graphs in which edges can link more than two nodes, you're more properly called a hyperedgelord.

Explanation

This is the third comic on How to annoy people. Here Cueball annoys White Hat, a graph theory Ph.D., by calling him an edgelord.

The exact same setting, with different text, was later used in 2744: Fanservice, and 2654: Chemtrails also used the same setting except it is Ponytail that gets annoyed.

"Edgelord" is modern slang describing a brash, pretentious provocateur on social media, often provoking in a satirical way that if taken literally would be found disturbing or insensitive. The term derives from the word "edgy", which is used to describe things which are designed to be provocative. "Edgy" and "edgelord" are quite derogatory, carrying further implications of being style over substance, or having appeal only with rambunctious teenagers.

In mathematics, graph theory is the study of graphs, mathematical structures made up of nodes (points) which are connected by edges (or lines). This comic plays on the fact that graphs have edges. Calling someone with a graph theory Ph.D. an 'edgelord' (a master of edges) is somewhat analogous to calling an engineering student a 'forcelord', an astronomy Ph.D. a 'starlord', or a pharmacologist a 'druglord'.

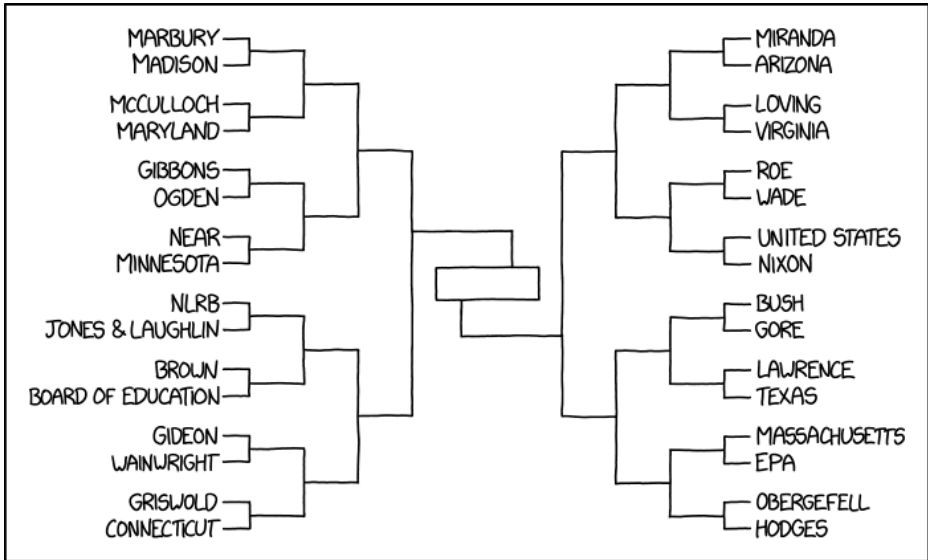
In reply to being called an edgelord by Cueball, White Hat shouts "No" and clenches his fists in anger - which is

ironic, as he seems to be on edge. Because "edgelord" is perceived as an insult by socially aware adults, Cueball is actually provoking White Hat, making Cueball an edgelord in this interaction. Similar situational humor is also found in 2008: Irony Definition.

The title text makes the same joke, except that the title would be hyperedgelord instead of edgelord. A hypergraph is a generalization of a graph in which each edge may have more than two endpoints. The term "hyper edge" could easily be considered stereotypically "edgy."

#2037: Supreme Court Bracket

August 24, 2018



NOW THAT WE'VE FINISHED THE ROUND OF 32, THE
SUPREME COURT WILL BE MOVING ON TO THE SWEET 16.

My bracket was busted in the first round; I had
Massachusetts v. Connecticut in the final, probably in a
case over who gets to annex Rhode Island.

Explanation

The Supreme Court of the United States is the highest federal court of the United States. A tournament bracket is a tree diagram that represents the series of games played during a knockout tournament. US Supreme Court cases are typically titled as Petitioner versus Respondent. To spoof this, Randall has put sixteen famous Supreme Court cases into a tournament bracket, as though they were games in the first round of a single-elimination tournament, and that the winners of the 16 listed court cases will somehow file against each other and then again until the final winner is selected. This is similar to college basketball's March Madness, complete with a ranking bracket. "Sweet 16" in the context of a tournament refers to the stage in a tournament where 16 competitors remain. This comic's concept is thus a word play on "court" (court of law v. basketball court). The phrase "Supreme Court Bracket" also sounds similar to "Supreme Court Docket", which is the official schedule of cases that the Supreme Court will adjudicate (as all of these cases have been).

The cases are:

The case *Marbury v. Madison* declared a provision of the Judiciary Act of 1789 unconstitutional, thus preventing several late-term appointments by outgoing President John Adams from being seated under incoming President Thomas Jefferson. More importantly, the ruling established the principle of judicial review by

which the Supreme Court can overturn, on the basis of unconstitutionality, laws passed by Congress and signed into law by the President. For this reason it is considered the single most important decision in American constitutional law.

The case *McCulloch v. Maryland* established a broad interpretation of the "necessary and proper" clause, specifically finding that Congress could incorporate a Bank of the United States because the purpose was to help carry out Congress' explicit powers under Article I, section 8.

The case *Gibbons v. Ogden* established that interstate commerce is regulated by the U.S. Congress according to the U.S. Constitution, that interstate navigation is fundamental to interstate commerce, and that therefore the power to regulate interstate navigation in this way rests with the U.S. Congress, not with any state legislature.

On 01 March 1824, the US Supreme Court decided in favor of Thomas Gibbons in his appeal of a case brought against him by Aaron Ogden in an attempt to prevent Gibbons from operating steamboats to transport goods and passengers between New York City, New York and Elizabethtown, New Jersey. The US Supreme Court decision reversed a prior injunction against Gibbons issued by a New York State court deciding that Ogden held exclusive navigational rights by way of having licensed them from two men to whom the New York State Legislature had granted the navigation rights in

several acts between 1798 and 1807.

The case *Near v. Minnesota* is a landmark United States Supreme Court decision that found that prior restraints on publication violate freedom of the press as protected under the First Amendment to the United States Constitution, a principle that was applied to free speech generally in subsequent jurisprudence. The Court ruled that a Minnesota law that targeted publishers of "malicious" or "scandalous" newspapers violated the First Amendment to the United States Constitution.

Noteworthy it was later a key precedent in *New York Times Co. v. United States* (1971), in which the court ruled against the Nixon administration's attempt to enjoin publication of the Pentagon Papers.

National Labor Relations Board v Jones & Laughlin Steel Corporation was a US labor law case. It declared that the National Labor Relations Act of 1935 was constitutional. It effectively preserved the New Deal, which was being pursued by US President Roosevelt in reaction to the Great Depression. Previous Supreme Court cases, unlike *NLRB v. Jones & Laughlin*, had invalidated New Deal statutes.

The case *Brown v. Board of Education* the Court declared state laws establishing separate public schools for black and white students to be unconstitutional. It stated that "separate educational facilities are inherently unequal."

This ruling paved the way for the Civil Rights Movement. However, the decision did not spell out any sort of method for ending racial segregation in schools, and the Court's second decision in *Brown II* only ordered states to desegregate "with all deliberate speed."

In the case *Gideon v. Wainwright* the Supreme Court unanimously ruled that states are required under the Sixth Amendment to the U.S. Constitution to provide an attorney or lawyer to defendants in criminal cases who are unable to afford their own attorneys.

In the case *Griswold v. Connecticut* (1965), the Court ruled that a statute barring birth control to prevent pregnancy, also known as contraception, was unconstitutional, at least in its application to married couples, as there was an implicit right to privacy in the "penumbras" and "emanations" of other constitutional provisions. This ruling was used as precedent in *Eisenstadt v. Baird* (1972), which extended the right to unmarried couples, and in *Roe v. Wade* and *Lawrence v. Texas* (see below).

In *Miranda v. Arizona*, it was ruled that inculpatory and exculpatory statements would not be accepted in court if a defendant was not informed of their rights under the Fifth Amendment. The "Miranda Rights" warning ("You have the right to remain silent", etc.) is now used across the US.

In *Loving v. Virginia* the Supreme Court ruled that state laws prohibiting interracial marriage were

unconstitutional, and were struck down. This decision was well ahead of public opinion; a Gallup poll (cited by Think Progress) conducted the following year showed only 20% in favor. This case was cited as precedent in *Obergefell v. Hodges*, listed below.

In *Roe v. Wade*, the Supreme Court ruled that a woman's right to privacy, balanced against the state's interest in limiting abortions, allowed women to undergo abortions in the first and second trimesters and allowed states the right to forbid third-trimester abortions.

It was overruled by *Dobbs v. Jackson Women's Health Organization* in 2022, allowing states the right to regulate abortion throughout all of pregnancy.

In *United States v. Nixon*, the Supreme Court unanimously ruled that then-President Richard Nixon's refusal to hand over certain tape recordings during his impeachment process was unconstitutional. This case placed limits on the power of executive privilege.

In *Bush v. Gore*, the Supreme Court decided the highly contested 2000 presidential election between George W. Bush and Al Gore, arguing in a 5-4 decision that the recount required by Florida state law could not be carried out before the December 12 deadline required by the United States Code. As such, the statewide recount was stopped, and the now-official initial count (which favored Bush) propelled Bush to the presidency.

Lawrence v. Texas ruled that sodomy laws were

unconstitutional, making same-sex sexual activity legal in all US states and territories. It explicitly overturned another Supreme Court decision, *Bowers v. Hardwick*, a case which had previously ruled such laws to be constitutional.

In *Massachusetts v. EPA*, Massachusetts and 11 other states sued the EPA for not regulating carbon dioxide and other greenhouse gases, saying that contrary to the claims of the EPA at that point in time, greenhouse gases are pollutants. In a 5-4 decision, the Supreme Court ruled in favor of the petitioners, forcing the EPA to start placing regulations on greenhouse gases.

In *Obergefell v. Hodges*, the Supreme Court ruled 5-4 that the right to marriage is protected for same-sex couples by the Fourteenth Amendment.

Sweet 16[edit]

With the results given above, the "Sweet 16" of the bracket given would be as follows:

- *Madison v. McCulloch*
- *Gibbons v. Near*
- *NLRB v. Brown*
- *Gideon v. Griswold*
- *Miranda v. Loving*
- *Roe v. United States*
- *Bush v. Lawrence*

- Massachusetts v. Obergefell

The title text refers to a practice of filling out a March Madness bracket, predicting a winner for each game up to the championship. A bracket is "busted" when the result of a game is not as predicted; because future matchups depend on previous results, the whole bracket is worthless at that point. Randall "had Massachusetts v. Connecticut in the final", predicting both parties would win all previous rounds and advance to the final game/case. Because Connecticut lost its first-round case to Griswold, his bracket is busted in the first round.

In the second part of the title text, Randall writes: "I had Massachusetts v. Connecticut in the final, probably in a case over who gets to annex Rhode Island." In fact, there actually was a Supreme Court case Massachusetts v. Connecticut (summary at Justia.com, full text at Google Scholar) dealing with water rights on the Connecticut River, which flows between the two states.

Rhode Island is a smaller state that borders both Massachusetts and Connecticut (and no other state), hence the joke about "who gets to annex Rhode Island."

In an actual March Madness bracket, "Massachusetts" and "Connecticut" refer to the basketball teams from the University of Massachusetts and the University of Connecticut. So it is possible that a "Massachusetts v. Connecticut" matchup could occur in the basketball championship as well.

#2038: Hazard Symbol

August 27, 2018



IT'S IMPORTANT TO KNOW THE INTERNATIONAL WARNING SYMBOL FOR RADIOACTIVE HIGH-VOLTAGE LASER-EMITTING BIOHAZARDS THAT COAT THE FLOOR AND MAKE IT SLIPPERY.

The warning diamond on the Materials Safety Data Sheet for this stuff just has the "" emoji in all four fields.

Explanation

Hazard symbols are often required to indicate certain threats to human health. These symbols are typically black symbols on yellow backgrounds, a contrast typically associated with danger even in nature, a phenomenon known as aposematism. However, these symbols also need to be easy to interpret. Therefore, they have simple, recognizable shapes that are internationally uniform and intended to be well-understood.

This comic inverts this latter expectation, by combining multiple hazard symbols into one, creating something that is unique, and very hard to understand. In practice, if such an object were to be labelled, the five hazard symbols would be separated, each in their own triangle.

The hazard symbols are biohazard , radiation , slip and fall hazard symbol, laser hazard, and high voltage symbol .

Another ridiculous aspect of this comic is how these hazards interact with each other, and their attendant risks. Radioactive waste is usually a show-stopper on its own, but bio hazards, lasers, and high-voltage situations usually scare people more than slippery floors. This is probably a joke on how some hazard symbols are worse than others. Some of these would also cancel each other out: both high voltage and lasers have a tendency to harm microorganisms that might be bio-hazards, and most radioactive substances are solid, thus they are hard to slip

on. While they do form compounds which could potentially be liquid and therefore slippery, many of these would kill the pathogens. For example, Uranium hexafluoride is a powerful oxidizer that would destroy most germs.

Biohazard and radioactivity could be combined as radioactive isotopes of Hydrogen, Carbon and Oxygen can be substituted for their stable counterparts, and high voltage electricity can be applied to anything. However laser hazard and slipping hazard seem to be mutually exclusive as the former applies to devices and the latter to substances. One possibly "solution" could be a room sized gas discharge tube filled with a radioactive biohazard that partly condenses and makes the floor slippery.

The title text refers to another unsafe subversion of expectations, in this case, against the NFPA 704 "fire diamond". These are the colorful diamond-shaped symbols often found on the back of tankers, but they are also necessary inclusions on materials safety datasheets. These symbols give numeric indication of the hazardous nature of the material, in three different respects (flammability, health, and reactivity), in addition to providing space for an extra warning on the bottom, typically in the form of one or more letters. Using an emoji instead of numbers and letters would defeat the purpose of the fire diamond, as it would only give a qualitative indication of the danger ("very dangerous"), and additionally, could be very easily mistaken for a 0 (meaning safe).

Note, Material Safety Data Sheets have been deprecated in favor of SDS (Safety Data Sheets) in order to come into compliance with the GHS (Globally Harmonized System).

is described by Emojipedia as "Anxious Face With Sweat". As an additional joke, using this symbol in the fire diamond could be an expression of how awful this mysterious substance is.

#2039: Begging the Question

August 29, 2018



I ANNOY PEOPLE ON ALL SIDES BY USING
"BEG THE QUESTION" TO MEAN "FIGHT A
LOSING BATTLE AGAINST CHANGING USAGE."

At least we can all agree on the enormity of this usage.

Explanation

This comic makes fun of the constant battle between those who maintain a prescriptive view of language and those who have a descriptive view. In the prescriptive view, language has fixed rules and fixed usage, and any usage that does not adhere to established rules is incorrect. In the descriptive view however, language is malleable and any usage can be correct if it is common and understood by most people.

The comic specifically calls out two phrases which are commonly misused in the prescriptive sense, and whose meanings have changed in modern usage in the descriptive sense:

Nauseous in its supposedly 'proper' form means "causing nausea", while nauseated means affected with nausea.

Prescriptively speaking, it is only correct to use the word "nauseous" to describe the food item since that was the cause of Ponytail's nausea. Saying "the food made her nauseous" would be interpreted, by a prescriptivist, as meaning the food somehow caused her (her body, her appearance, etc.) to become so disgusting that she now causes other people to feel nausea. As White Hat states, the proper phrasing is that the "the food was nauseous", and it "made [her] nauseated".

Both historically and in modern usage, however, "nauseous" is a valid synonym of "nauseated". It is

difficult, if not impossible, to cite an era of history when most people would not understand "she is nauseous" to mean she does not feel well.

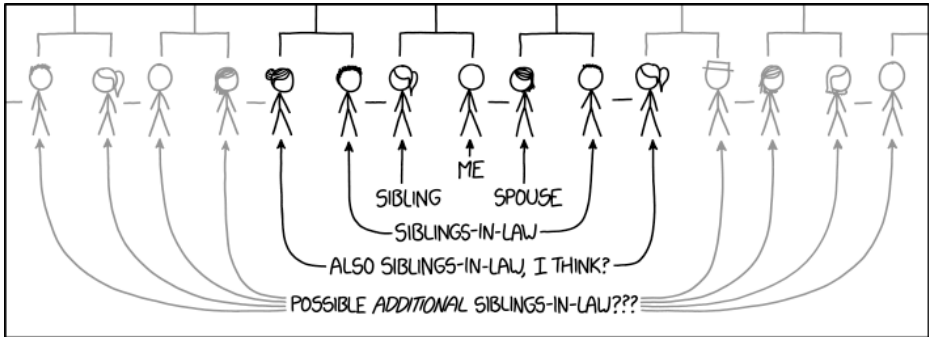
Begging the question originally referred to a logical fallacy where an argument assumed its conclusion. The phrase first meant to question (beg) the original question. In modern usage, it has come to mean to "raise a question or point that has not been dealt with". This is often a point of contention for prescriptivists. However, as the caption explains, Cueball has an entirely different meaning for this phrase that he created himself: "fight a losing battle against changing usage". This is actually a meta-meaning, as that is actually the common activity of prescriptivists who complain about incorrect usage; it's a losing battle, because language change is inevitable and unstoppable. And specifically, trying to preserve the original meaning of "begging the question" is a losing battle.

Ponytail might recognize that her exposure to nauseous food has both nauseated her and caused her to become nauseous to Cueball. The question is not merely begged, it is missed.

The title text also plays on another word commonly argued over by prescriptivists. "Enormity" in its classical usage means either extreme wickedness or a monstrous offense or evil, though it is more commonly used in modern writing as a synonym for enormousness (i.e. largeness in size). The title text exploits the lexical ambiguity that this creates.

#2040: Sibling-in-Law

August 31, 2018



PEOPLE COMPLAIN THAT "<X>TH COUSIN <Y> TIMES REMOVED" IS HARD TO UNDERSTAND, BUT TO ME THE MOST CONFUSING ONE IS SIBLING-IN-LAW, BECAUSE IT CHAINS ACROSS BOTH SIBLING AND MARRIAGE LINKS AND I DON'T REALLY KNOW WHERE IT STOPS.

FYI, it turns out "...because I haven't figured out whether he would be my brother-in-law or not" does **NOT** qualify as a "reason why these two should not be wed."

Explanation

This comic shows the complicated way that English refers to sibling-in-law family relationships. As shown in the comic, your sibling's spouse would be called your "sibling-in-law" (brother-in-law for male, sister-in-law for female). However, your spouse's sibling is also called the same way.

The confusion lies with your siblings-in-law's siblings. Randall says they may be "also siblings-in-law, I think?" and further relations are also "possible additional siblings-in-law".

According to Wikipedia, "sibling-in-law is one's spouse's sibling, or one's sibling's spouse, or one's spouse's sibling's spouse"; therefore Randall would be correct with the "also siblings-in-law" on the right (his 'spouse's sibling's spouse') but would be incorrect regarding the one on the left (his 'sibling's spouse's sibling' would not generally be considering a sibling-in-law).

Wiktionary lists a more restrictive definition: siblings-in-law are either "the sibling of one's spouse" or "the spouse of one's sibling". This definition includes only those whom Randall calls siblings-in-law, and none of those he calls "also siblings-in-law, I think?". The spouse of the sibling of one's spouse or the sibling of the spouse of one's sibling are to be referred as co-siblings-in-law. If anything, this shows that the definition of a sibling-in-law is loose, justifying the "I think?" sentence of the comic.

Many families also use the term "out-law" to jokingly refer to the distant sibling+spouses which Randall seems uncertain about.

The caption compares "sibling-in-law" to "<X>th cousin <Y> times removed". This family relationship, for example, 1st cousin once removed, is used to describe your 1st cousin's child or the first cousin of one of your parents. The "once removed" indicates that the family relative is one generation above or below yours.

The title text describes a scenario in a traditional wedding in most English-speaking regions. Prior to the wedding being completed, the officiant will provide a final opportunity for anyone in the audience to speak a reason to object to the wedding. This intended for reasons why they cannot lawfully be wed -- such as that one of the participants is already married to someone else or is too young to marry, that the couple are so closely related that the marriage would be incestuous, or that the marriage license is expired -- or other serious emergencies -- such as evidence of infidelity (sexual or otherwise) that might change one of the participants' minds about their continued commitment to their spouse-to-be. In movies and fiction, this is usually a dramatic moment used for the climax of a critical scene. Regardless, it is an incredibly serious objection to raise, and should not be done so lightly. However, the title text describes a confusing and mundane scenario where the only reason the speaker is objecting to the wedding is because they're unsure whether the marriage would make one of the participants their brother-in-law and thus wouldn't

know what to call the groom after the wedding. In order to avoid their own confusion, they attempted to stop the wedding altogether. The officiator rightly ruled that this objection was neither just cause to object nor a reason that the wedding would be unlawful, and is therefore no reason the couple should be prevented from their own chance at wedded bliss.

Since the title text begins with a FYI (for your information) it is implied that Randall has actually tried to stop a wedding using that reason and has been overruled, and thus he wishes to help others avoid that socially-awkward experience.

#2041: Frontiers

September 03, 2018



FINAL REMAINING "FRONTIERS,"
ACCORDING TO POPULAR USAGE

Star Trek V is a small part of the space frontier, but it's been a while since that movie came out so I assume we've finished exploring it by now.

Explanation

This comic refers to four remaining “final frontiers” of human discovery, according to popular usage—perhaps analyzed using an Internet search engine. It seems to imply that other fields of research aren’t a challenge anymore.

Outer space is so vast in size that it’s impossible for humans to discover even just the stars in our galaxy within a lifetime, as astronomers estimate that there are 100 to 400 billion stars in the Milky Way. Space travel is also very difficult and expensive.

The oceans are very deep. The vast majority of the deeper oceans hasn’t been visited by humans, and there is still much we don’t know about the living beings in the deep sea. Around 95% of the oceans haven’t been explored and mapped by humans.[actual citation needed]

The human mind is not only very complex, but also often seems irrational, which makes it harder to investigate. Its relation to the brain is also somewhat mysterious: philosophy of mind is split on whether the mind is ultimately material (materialism) or immaterial (dualism/idealism). Further, certain philosophical systems have trouble explaining its relation to the body, in what is termed the mind–body problem.

Alaska is the state of largest area in the U.S., and also the most sparsely populated. Many places in Alaska have

only been partially explored to this day. Randall was probably inspired by the TV series *Alaska: The Last Frontier*, which plays off of the state's official nickname of "The Last Frontier".

The humor from this comic comes from the fact that Alaska seems comparably of less important than the other "Final Frontiers". It is not as hard or expensive to explore as the ocean bottom and outer space, and it is much smaller. While one's own human mind is much more easily accessible than the other three locations, its nature is a substantial frontier in human knowledge. Furthermore, minds other than one's own are very hard to access.

The title text refers to the movie *Star Trek V: The Final Frontier*, released in 1989. "Final frontier" is a recurring motif in the *Star Trek* franchise (coming from the opening narration for *Star Trek: The Original Series*), and is used to describe the exploration of outer space, which remains a notable frontier to humans, both in real life and within *Star Trek*. Randall, however, jokingly posits that the frontier to be explored is the film itself, and assumes that, because this movie has been out for a while—nearly thirty years—it ought to be fully and comprehensively explored by now.

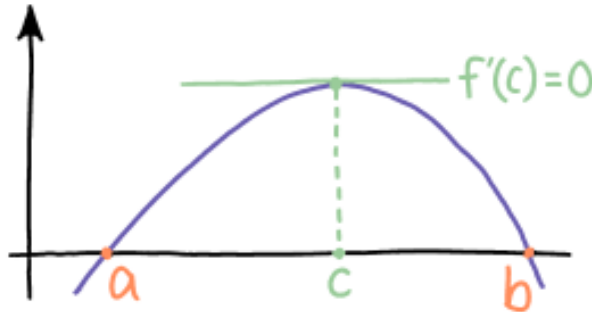
#2042: Rolle's Theorem

September 05, 2018

ROLLE'S THEOREM

FROM WIKIPEDIA, THE FREE ENCYCLOPEDIA

ROLLE'S THEOREM STATES THAT ANY REAL, DIFFERENTIABLE FUNCTION THAT HAS THE SAME VALUE AT TWO DIFFERENT POINTS MUST HAVE AT LEAST ONE "STATIONARY POINT" BETWEEN THEM WHERE THE SLOPE IS ZERO.



EVERY NOW AND THEN, I FEEL LIKE THE MATH EQUIVALENT OF THE CLUELESS ART MUSEUM VISITOR SQUINTING AT A PAINTING AND SAYING "C'MON, MY KID COULD MAKE THAT."

I mean, if it's that easy to get a theorem named for you ... "a straight line that passes through the center of a coplanar circle always divides the circle into two equal halves." Can I have that one? Wait, can I auction off the

naming rights? It can be the Red Bull Theorem or the Quicken Loans Theorem, depending who wants it more.

Explanation

In mathematics, a differentiable function is a function that is "smooth" everywhere, without any sudden breaks or pointy "kinks" or similar. The derivative of such a function is a new function that represents the "slope" or "rate of change" of the original. The function in this comic curves up from point (a) until a point above (c), smoothly turns around, and then curves down from (c) to (b). As a result, the derivative of this function is positive from (a) to (c), and then is negative from (c) to (b). At (c) itself, the function is "flat": the more one zooms in, the more horizontal it looks. The function is moving neither up nor down, so the derivative is neither positive nor negative, but zero. This is what $f'(c) = 0$ means, as f' is a common notation for the derivative of the function f in differential calculus.

A theorem in mathematics is a statement that has been proven from former accepted statements, like other theorems or axioms. This comic references Rolle's theorem. The theorem essentially states that, if a smoothly changing function has the same output at two different inputs, then it must have one or more turning points in between, as the derivative is zero at each one. As a special case, should the function remain flat between the two inputs, then its derivative is actually zero for every point between the inputs. To Randall, this is obvious. However, the proof of this theorem is not as obvious as the result.

The seeming triviality of the theorem, coupled with the honour bestowed on the theorem namer, leads Randall to make a comparison to attendees of art museums who look at abstract art pieces and perceive only an apparent technical simplicity in the work. Such a visitor might exclaim "My child could paint that!". However, such works of art typically are seen as having value from attributes other than the painterly difficulty in achieving the piece. For example, an artist's work in this style may be lauded for its visionary qualities, or the emotions expressed through the choice of colours or textures. One such artist is Jackson Pollock. The 'clueless' visitor does not see these aspects and believes their child could imitate the piece. Randall suggests he experiences a similar feeling looking at Rolle's Theorem and noting only the obvious correctness without acknowledging the complicated nature of the proof, or other hidden aspects of the theorem.

In the title text, Randall mentions a line together with a coplanar circle. This simply means that both those two-dimensional objects must lay in the same plane in a higher, three-or-more-dimensional space. And by this means, every line drawn through the center of a circle is just a diameter which divides it into two equal parts. Even if this fact is trivial, even the legendary Proclus admits that the first man who proved it was Thales. Auctioning of naming rights, also noted in the title text, refers to the practice of naming entertainment venues for companies which pay for the privilege, such as any of the three Red Bull Arenas or Quicken Loans Arena. (See

"Are there any theorems/objects involving company names." on r/math.) The naming of mathematical theorems (along with lemmas, equations, laws, methods, etc.) is not always straightforward and often results in misleading names.

Randall implies that there are many seemingly easy theorems like this. For instance the Dirichlet's box principle, also known as the Pigeonhole principle, which states that if you have more objects than containers, you're going to have to put at least two objects in one container.

#2043: Boathouses and Houseboats

September 07, 2018

<p>A THIS → THAT HOLDS THIS ↓ CAR</p> <p>HOUSE</p> <p>BOAT</p>	CAR	HOUSE	BOAT
	TOW TRUCK CARCAR	GARAGE CARHOUSE	CAR FERRY CARBOAT
	MOBILE HOME HOUSECAR	APARTMENT HOUSEHOUSE	HOUSEBOAT
	BOAT TRAILER BOATCAR	BOATHOUSE	LIFEBOAT BOATBOAT

I REALLY LIKE THE WORDS FOR "BOATHOUSE" AND "HOUSEBOAT" AND THINK WE SHOULD APPLY THAT SCHEME MORE CONSISTENTLY.

The <x> that is held by <y> is also a <y><x>, so if you go to a food truck, the stuff you buy is truck food. A phone that's in your car is a carphone, and a car equipped with a phone is a phonecar. When you play a mobile racing game, you're in your phonecar using your carphone to drive a different phonecar. I'm still not sure about bananaphones.

Explanation

Most English compound nouns can be constructed recursively. In many cases they are written open or spaced like "piano player" (a player of a piano) or "player piano" (a piano capable of unattended operation). But closed forms like "wallpaper" (paper for a wall) are not less common. Some other languages have many more compound words: The German word for "hospital" literally means "patient's house," and the Swedish word for "house trailer" literally means "house car".

Randall is engaging in creative linguistics again. This time he is humorously suggesting to use a consistent naming scheme for things holding other things, the same way we call a boat holding a house a houseboat. He is extending this to all combinations boats, houses and cars. This would, however, be somewhat impractical, as these names do not include why one thing is on an other, and are also sometimes ambiguous: a carcar can be a tow truck as much as a car carrier, and a househouse can be either an apartment (house in a house) or an apartment building (house containing houses).

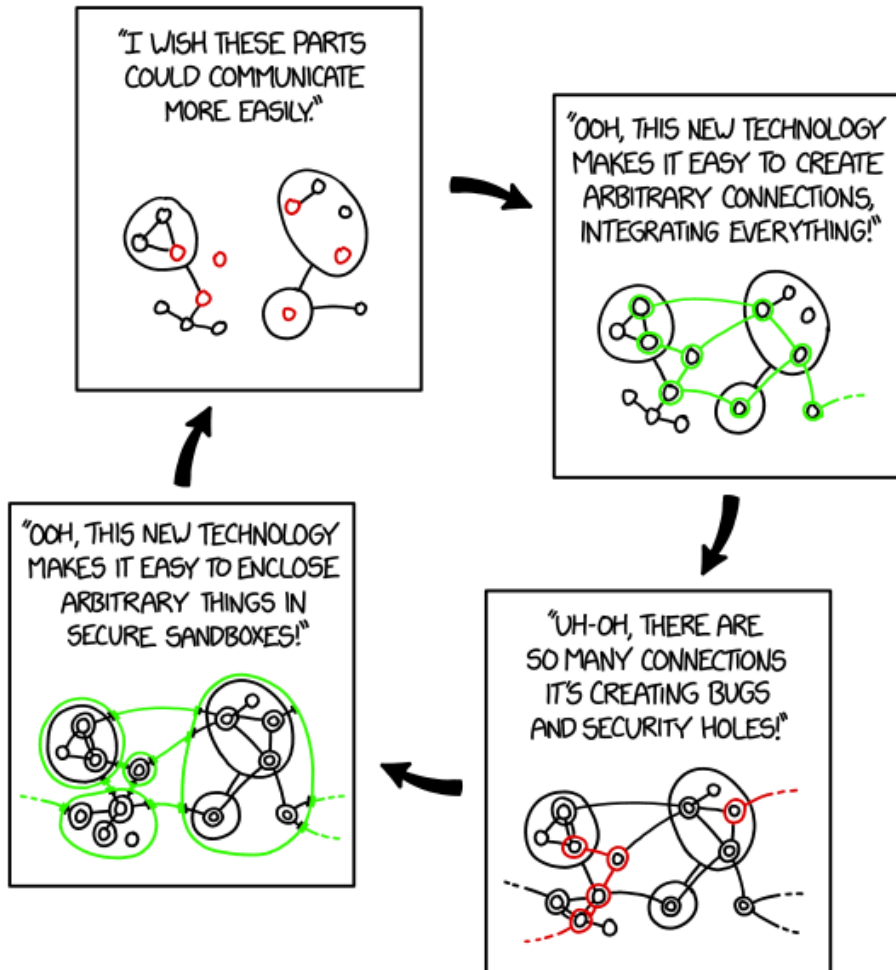
Additionally, he is somewhat inconsistent in some parts of the chart. While the chart is supposed to show examples of neologistic compound words $\langle x \rangle \langle y \rangle$ that refer to a $\langle y \rangle$ that holds an $\langle x \rangle$, rather than a $\langle y \rangle$ in an $\langle x \rangle$. However, Randall's examples sometimes are those of the latter example. He proposes to call lifeboats, which are boats held by other boats, "boatboat", instead of

using that to refer to boats holding other boats, such as floating drydocks. Additionally, it is established naval practice to refer to a boat which is carried by another vessel as a "ship's boat", and call any vessel that carries a boat a "ship". In other words, according to usual naval terminology, a "boatboat" is a contradiction in terms; it is either a "boatship", synonymous with ship and hence redundant, or a "shipboat", the ship's boat. "Apartment" is a similar case: an apartment is a house in a house, while a house that holds a house is an apartment building or apartment complex. (However, in the title text, Randall points out an $\langle x \rangle \langle y \rangle$ could also refer to a $\langle y \rangle$ in an $\langle x \rangle$, similar to the lifeboat and apartment examples. Nevertheless, "lifeboat" and "apartment" do not fit with the rest of the items of the chart and disobey the rule annotated in the corner.)

In the title text: "Truck food" is in some areas a common term for the meals offered by "food trucks." Car phones were a feature in automobiles throughout the late 1960s, 1970s and 1980s, serving as the predecessors to mobile phones, although they were permanently installed into a car and not mobile. Bananaphone, a song by Raffi Cavoukian, is also mentioned.

#2044: Sandboxing Cycle

September 10, 2018



All I want is a secure system where it's easy to do anything I want. Is that so much to ask?

Explanation

A sandbox or sandpit is a playground where children can play safe without interfering with the world outside. By this meaning the term was adopted by others like the sand table in military uses, or as a Wikipedia Sandbox, a playground for inexperienced editors to test their additions, and in computer security (sandbox) which Randall probably references at this comic.

Software is getting more and more complex, and in an effort to reduce programming work and security vulnerabilities, large applications are composed of multiple programs. Getting these mostly self-contained programs to work with each other can be tricky, since requirements can vary a lot between different applications, requiring a rather general interface or API for communication. The more open such interfaces are, the higher the risk of unintended side effects, like vulnerabilities and overly permissive data access which could be exploited by hackers.

At the top left panel it could be a software collection whose parts are not yet fully connected to each other; the parts of the system which are as yet unconnected are shown in red, symbolizing a problem. A simple example is a typical office suite used for documents, presentations, spreadsheets, charts, databases, and more. In the early days those separate applications weren't much connected together, copy and paste was one of the most important features; which suggests the applications

haven't yet been fully developed. However, software is never fully developed, improvements can always be made.

The next panel uses some "new technology" (in green, representing a solution) to interconnect those parts not only internal, but also to the world outside at the internet. In the simple office suite example, this means a document can now use a spreadsheet directly by using just a simple connection to another file. If that spreadsheet is changed the document uses this new content without any need of copying it manually.

But this leads to the third panel, with undesired connections shown in red. The undesired connections mean that problems in specific applications may spread to other applications because nobody can oversee everything in a large environment. It even may destroy the original document in the office suite example, or allow malicious users to exploit security holes.

The fourth panel shows (in green, representing a solution) a method applied to this problem known as sandboxing. This is a security mechanism for separating running programs without risking harm to others. This can tighten up sloppy security. A direct consequence of restricted communication is that the programs now again can't connect easily to each other, resulting in a situation very similar to the first panel and restarting the "sandboxing cycle."

The point made by this comic is that it is often difficult

to easily use a system without lowering security in that system; a dilemma that can be found both in the office suite example above, or the social media example below.

The dilemma is again stated in the title text: Randall wants both ease of use and high security. In practice, a tradeoff has to be made.

For an unrelated xkcd on cycles and security, see 2677: Two Key System.

#2045: Social Media Announcement

September 12, 2018

WHY I'M QUITTING FACEBOOK,
JOINING LINKEDIN, DELETING MY
LINKEDIN, REJOINING FACEBOOK,
QUITTING TWITTER, GETTING
LOCKED OUT OF FACEBOOK,
MOVING TO MASTODON, AND
LOBBYING MICROSOFT TO TAKE
OVER MASTODON AND MERGE
IT WITH LINKEDIN: A MANIFESTO.



Why I'm Moving Most of My Social Activity to Slack, Then
Creating a Second Slack to Avoid the People in the First
One, Then Giving Up on Social Interaction Completely,
Then Going Back to Texting

Explanation

In 2018, especially after Facebook privacy abuses were revealed in the Facebook-Cambridge Analytica scandal, many individuals began seeking alternatives. The #deletefacebook hashtag peaked around April 2018, and in some communities, this type of "why I'm leaving Facebook" announcements were popular. Randall parodies this mentality with Cueball, who wants to think he is making a point about standing by his values, values he assumes other people share. However the overly-long title of his manifesto is too specific to apply to anyone but himself, and also reveal a few embarrassing confessions that probably have nothing to do with his values (such as losing his Facebook password).

Mastodon is a distributed, federated social network with microblogging features similar to Twitter. "Federated" means that there is one app hosted in many places, so users can choose a host that meets their needs, but everyone can still talk to each other, similar to email. Near the peak of #deletefacebook, Mastodon became trending as a Twitter alternative with less Nazis. Wil Wheaton famously moved to Mastodon from Twitter, but was ultimately disappointed by the experience, because while Mastodon's community is generally less toxic, it does not yet have the tools to handle the kind of targeted harassment that a celebrity might face.

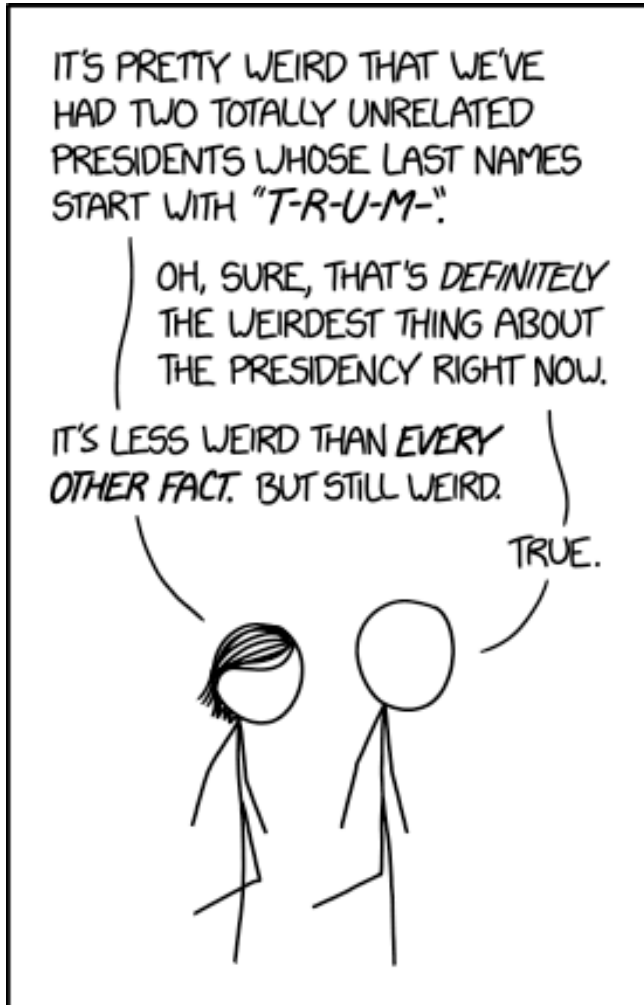
Microsoft has been buying up professional-themed social media platforms lately, such as LinkedIn and GitHub,

intending to integrate them more fluidly with their enterprise software suite. Mastodon seems an unlikely target for an acquisition, since its decentralized nature means that one corporate entity can't control it, and the culture there is decidedly unprofessional as of this comic.

The title text presents an alternative approach by moving most social activities to the cloud-based proprietary team collaboration platform Slack. After making his first workspace in Slack he suggests that he wishes to avoid the people invited, so he creates a second account and a new workspace. This also didn't last long and he stops interacting on social media entirely and reverted to simple texting, probably sending old fashioned SMS-messages to others or just writing texts on paper no one reads.

#2046: Trum-

September 14, 2018



Excited to vote for future presidents Bill Eisenhamper, Amy Forb, Ethan Obample, and Abigail Washingtoast.

Explanation

The President of the United States, at the time when this comic was published, was Donald Trump and he shares the first letters of his surname with Harry S. Truman, who was US President between 1945 and 1953. Megan notes that both of these presidents' last names start with "T-R-U-M", but she also states that they are not related.

There were several presidents of the US who even have the exact same last name. For example, John Adams and his son John Quincy Adams, and the more recent father and son George H. W. Bush and George W. Bush. Similarly Theodore Roosevelt and Franklin Delano Roosevelt are 5th cousins. Grandfather and grandson William Henry Harrison and Benjamin Harrison also share a last name. And there are the two most distantly related presidents with the same surname, both Andrew Johnson and Lyndon B. Johnson have the last name of Johnson (7 letters), although the shared last name is coincidental, given they do not share any relatives with the name Johnson.

Besides T-R-U-M- and the cases of identical names, the longest common surname prefix is H-A-R (3 letters), shared by William Henry (or Benjamin) H-A-R-rison and Warren Gamaliel H-A-R-ding. If Kamala Harris had prevailed in the 2024 presidential election, she would have brought the record up to 6 letters, sharing her entire last name with the first six letters of the two Harrisons. (The next longest common surname prefixes are B-U-,

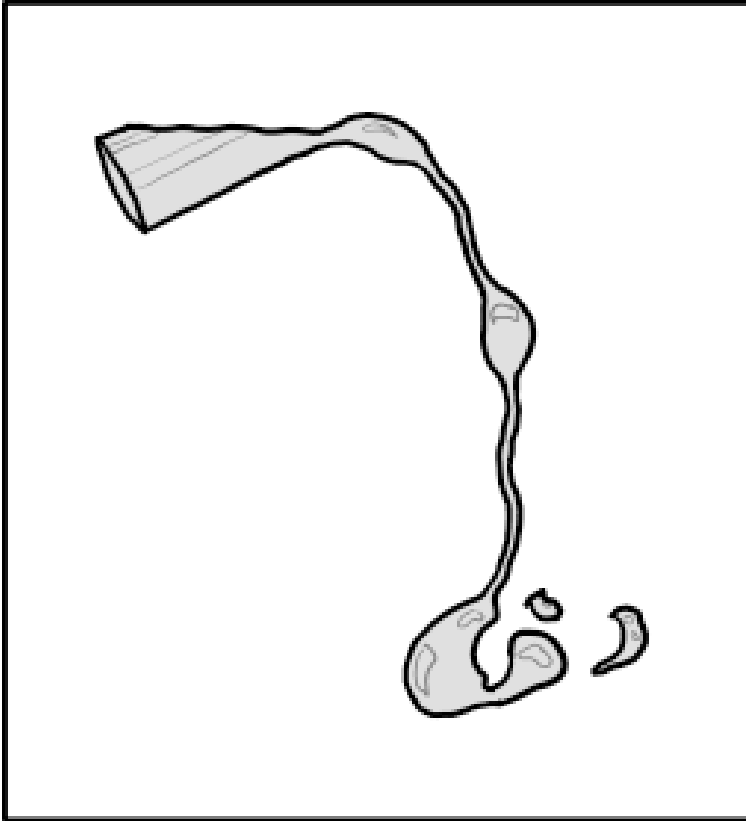
shared by James B-U-CHANAN and George (H.) W. Bush; and C-L-, shared by Grover Cleveland and Bill Clinton.). The longest common suffix (not counting identical names) is also 4 for I-S-O-N for James Madison and the two Harrison presidents. Interestingly, the name HARRISON contains both the second-longest common prefix and the longest common suffix among non-identical president surnames.

The joke is that the matching of those few letters is the least weird thing. Trump's presidency is commonly considered weird in ways too varied to concisely list in this article. Both Megan and Cueball seem to agree on this.

The title text lists "absurd" last names that could start with the same letters as other presidents: Bill Eisenhamper, Amy Forb, Ethan Obample, and Abigail Washingtoast. These would refer to Dwight D. Eisenhower, Gerald Ford, Barack Obama, and George Washington.

#2047: Beverages

September 17, 2018



IT FREAKS ME OUT TO IMAGINE WHAT
A BEVERAGE IS SHAPED LIKE WHEN
I'M IN THE MIDDLE OF DRINKING IT.

If I wait a while, it's not so bad, because then it's just shaped like me, plus some pipes and tanks and probably eventually all of Earth's oceans.

Explanation

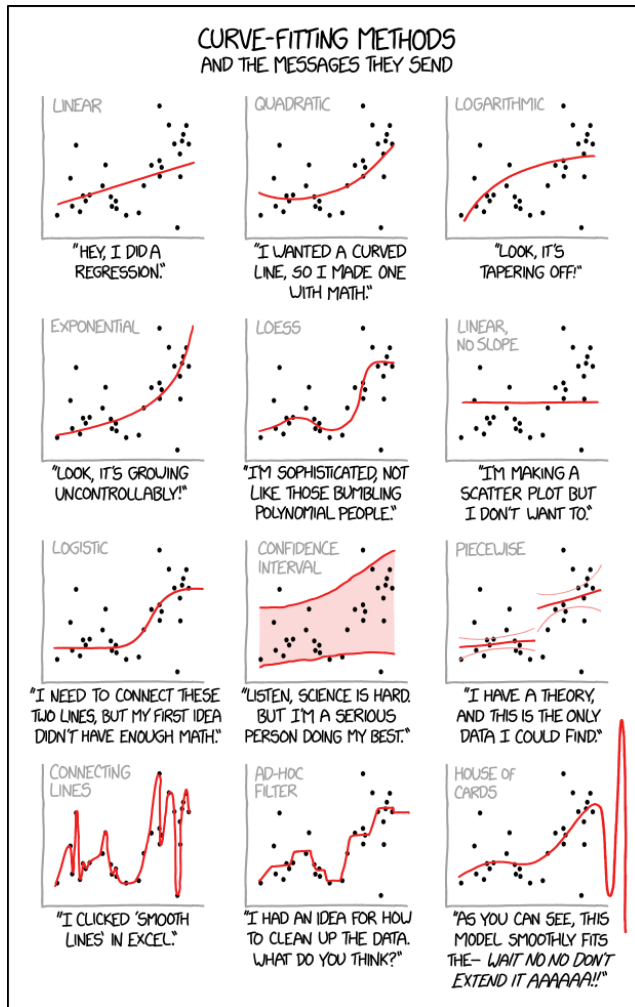
It is frequently stated that liquids take the shape of their container. While being poured, though, what that "shape" is is open to interpretation. The comic shows the "shape" of a liquid being "poured" down someone's throat (in the process of drinking) and highlights how unsettling this may look without any visible guidance for its flow. While the flow of the beverage wets every parts downwards, it looks as if the stomach is only partially filled, because the process of drinking is still underway and the glass is still half full, and because the contents of the glass would not be enough to fill the stomach in any case. Therefore the shape of the liquid in the stomach area would not correspond to the full shape of the stomach, and there could be additional blobs of liquid where it might have splashed and detached from the main liquid mass, such as depicted by the two little disconnected pieces to the right of the stomach area.

The title text expands on this, encouraging the reader to think of the liquid travelling through the entire human digestive tract and to consider that it will eventually dilute through the entire human body ("shaped like me"), with what doesn't leaving the body to pass through the water treatment process ("some pipes and tanks"), and that finally most particles from any ingested liquid will mix with all water on Earth ("all of Earth's oceans"). But by the time a beverage is diluted enough to take the shape of Earth's oceans, the molecules will be so dispersed that the beverage effectively becomes invisible.

Note: A barium swallow is a medical procedure that actually studies the shape of a liquid when it is being swallowed, to diagnose problems in the esophagus and other structures.

#2048: Curve-Fitting

September 19, 2018



Cauchy-Lorentz: "Something alarmingly mathematical is happening, and you should probably pause to Google my name and check what field I originally worked in."

Explanation

An illustration of several plots of the same data with curves fitted to the points, paired with conclusions that you might draw about the person who made them. These data, when plotted on an X/Y graph, appear to have a general upward trend, but the data is far too noisy, with too few data points, to clearly suggest any specific growth pattern. In such a case, many different mathematical and statistical models could be presented as roughly fitting the data, but none of them fits well enough to compellingly represent the data.

When modeling such a problem statistically, much of the work of a data scientist or statistician is knowing which fitting method is most appropriate for the data in question. Here we see various hypothetical scientists or statisticians each applying their own interpretations to the exact same data, and the comic mocks each of them for their various personal biases or other assorted excuses. In general, the researcher will specify the form of an equation for the line to be drawn, and an algorithm will produce the actual line.

Nonetheless scientists work much more seriously on the reliability of their assumptions by giving a value for the standard deviation represented by the Greek letter sigma σ or the Latin letter *s* as a measure to quantify the amount of variation of the data points against the presented best fit. If the σ -value isn't good enough an interpretation based on a specific fit wouldn't be

accepted by the science community.

Since Randall gives no hint about the nature of the used data set - same in each graph - any fitting presented doesn't make any sense. The graphs could represent a star map, the votes for the latest elected presidents, or your recent invoices on power consumption. This comic just exaggerates various methods on interpreting data, but without the knowledge of the matter in the background nothing makes any sense.

Linear[edit]

Linear regression is the most basic form of regression; it tries to find the straight line that best approximates the data. As it's the simplest, most widely taught form of regression, and in general differentiable functions are locally well approximated by a straight line, it's usually the first and most trivial attempt of fit.

The picture to the right shows how totally different data sets can result in the same line. It's obvious that some more basics about the nature of the data must be used to understand if this simple line really does make sense.

The comment below the graph "Hey, I did a regression." refers to the fact that this is just the easiest way of fitting data into a curve.

Quadratic[edit]

Quadratic fit (i.e. fitting a parabola through the data) is the lowest grade polynomial that can be used to fit data through a curved line; if the data exhibits clearly "curved" behavior (or if the experimenter feels that its growth should be more than linear), a parabola is often the first, easiest, stab at fitting the data.

The comment below the graph "I wanted a curved line, so I made one with math." suggests that a quadratic regression is used when straight lines no longer satisfy the researcher, but they still want to use simple math expression. Quadratic correlations like this are mathematically valid and one of the simplest kind of curve in math, but this curve doesn't appear to satisfy the data any better than does simple, linear regression.

Logarithmic[edit]

A logarithmic curve grows slower on higher values, but still grows without bound to infinity rather than approaching a horizontal asymptote. The small b in the formula represents the base which is in most cases e , 10, or 2. If the data presumably does approach a horizontal asymptote then this fit isn't an effective method to explain the nature of the data.

The comment below the graph "Look, it's tapering off!" builds up the impression that the data diminishes while under this fit it's still growing to infinity, only much slower than a linear regression does.

Exponential[edit]

An exponential curve, on the contrary, is typical of a phenomenon whose growth gets rapidly faster and faster - a common case is a process that generates stuff that contributes to the process itself; think bacteria growth or compound interest.

The logarithmic and exponential interpretations could very easily be fudged or engineered by a researcher with an agenda (such as by taking a misleading subset or even outright lying about the regression), which the comic mocks by juxtaposing them

side-by-side on the same set of data.

The comment below the graph "Look, it's growing uncontrollably!" gives an other frivolous statement suggesting something like chaos. Also this even faster growth is well defined and has no asymptote at both axes.

LOESS[edit]

A LOESS fit doesn't use a single formula to fit all the data, but approximates data points locally using different polynomials for each "zone" (weighting data points differently as they get further from it) and patching them together. As it has many more degrees of freedom compared to a single polynomial, it generally "fits better" to any data set, although it is generally impossible to derive any strong, "clean" mathematical correlation from it - it is just a nice smooth line that approximates the data points well, with a good degree of rejection from outliers.

The comment below the graph "I'm sophisticated, not like those bumbling polynomial people." emphasises this more complicated interpretation, but without a simple mathematical description it's not very helpful to find informative interpretations of the underlying data.

Linear, No Slope[edit]

Also known as a constant function, since the function takes on the same (constant) value c for all values of x . The value of c can be determined simply by taking the average of the y -values in the data.

Apparently, the person making this line figured out pretty early on that their data analysis was turning into a scatter plot, and

wanted to escape their personal stigma of scatter plots by drawing an obviously false regression line on top of it. Alternatively, they were hoping the data would be flat, and are trying to pretend that there's no real trend to the data by drawing a horizontal trend line.

The comment below the graph "I'm making a scatter plot but I don't want to." is probably done by a student who isn't happy with their choice of field of study.

Logistic[edit]

The logistic regression is taken when a variable can take binary results such as "0" and "1" or "old" and "young".

The curve provides a smooth, S-shaped transition curve between two flat intervals (like "0" and "1").

The comment below the graph "I need to connect these two lines, but my first idea didn't have enough math." implies the experimenter just wants to find a mathematically-respectable way to link two flat lines.

Confidence Interval[edit]

Not a type of curve fitting, but a method of depicting the predictive power of a curve.

Providing a confidence interval over the graph shows the uncertainty of the acquired data, thus acknowledging the uncertain results of the experiment, and showing the will not to "cheat" with "easy" regression curves.

The comment below the graph "Listen, science is hard. But I'm a serious person doing my best." is just an honest statement about

this uncertainty.

Piecewise[edit]

Mapping different curves to different segments of the data. This is a legitimate strategy, but the different segments should be meaningful, such as if they were pulled from different populations.

This kind of fit would arise naturally in a study based on a regression discontinuity design. For instance, if students who score below a certain cutoff must take remedial classes, the line for outcomes of those below the cutoff would reasonably be separate from the one for outcomes above the cutoff; the distance between the end of the two lines could be considered the effect of the treatment, under certain assumptions. This kind of study design is used to investigate causal theories, where mere correlation in observational data is not enough to prove anything. Thus, the associated text would be appropriate; there is a theory, and data that might prove the theory is hard to find.

One notable time this is used is when a researcher studying housing economics is trying to identify housing submarkets. The assumption is that if two proposed markets are truly different, they will be better described using two different regression functions than if one were to be used.

The additional curved lines visible in the graph are the kind of confidence intervals you'd get from a simple OLS regression if the standard assumptions were valid. In the case of two separate regressions, it would be surprising if all those assumptions (that is, i.i.d. Normal residuals around an underlying perfectly-linear function) were in fact valid for each part, especially if the slopes

are not equal.

A classical example in physics are the different theories to explain the black body radiation at the end of the 19th century. The Wien approximation was good for small wavelengths while the Rayleigh–Jeans law worked for the larger scales (large wavelength means low frequency and thus low energy.) But there was a gap in the middle which was filled by the Planck's law in 1900.

The comment below the graph "I have a theory, and this is the only data I could find." is a bit ambiguous because there are many data points ignored. Without an explanation why only a subset of the data is used this isn't a useful interpretation at all. As a matter of fact, with the extra degrees of freedom offered by the piecewise regression, it could indicate that the researcher is trying to fit the data to confirm their theory, rather than building their theory off of the data.

Connecting lines[edit]

This is often used to smooth gaps in measurements. A simple example is the weather temperature which is often measured in distinct intervals. When the intervals are high enough it's safe to assume that the temperature didn't change that much between them and connecting the data points by lines doesn't distort the real situation in many cases.

The comment below the graph "I clicked 'Smooth Lines' in Excel." refers to the well known spreadsheet application from Microsoft Office. Like other spreadsheet applications it has the feature to visualize data from a table into a graph by many ways. "Smooth Lines" is a setting meant for use on a line graph, a graph in which one axis represents time; as it simply joins up every point

using bezier (or similar) curves as necessary to pass through every point (rather than finding a more sensible line that accepts some minimal but non-zero acceptable level of error in the datapoints), it is not suitable for regression.

Ad-Hoc Filter[edit]

Drawing a bunch of different lines by hand, keeping in only the data points perceived as "good". Not really useful except for marketing purposes.

The comment below the graph "I had an idea for how to clean up the data. What do you think?" admits that in fact the data is whitewashed and tightly focused to a result the presenter wants to show.

House of Cards[edit]

Not a real method, but a common consequence of misapplication of statistical methods: a curve can be generated that fits the data extremely well, but immediately becomes absurd as soon as one glances outside the training data sample range, and your analysis comes crashing down "like a house of cards". This is a type of overfitting. In other words, the model may do quite well for (approximately) interpolating between values in the sample range, but not extend at all well to extrapolating values outside that range.

Note: Exact polynomial fitting, a fit which gives the unique n th degree polynomial through $n+1$ points, often display this kind of behaviour.

The comment below the graph "As you can see, this model smoothly fits the- wait no no don't extend it AAAAAA!!" refers

to a curve which fits the data points relatively well within the graph's boundaries, but beyond those bounds fails to match at all.

Cauchy-Lorentz (title text)[edit]

Cauchy-Lorentz is a continuous probability distribution which does not have an expected value or a defined variance. This means that the law of large numbers does not hold and that estimating e.g. the sample mean will diverge (be all over the place) the more data points you have. Hence very troublesome (mathematically alarming).

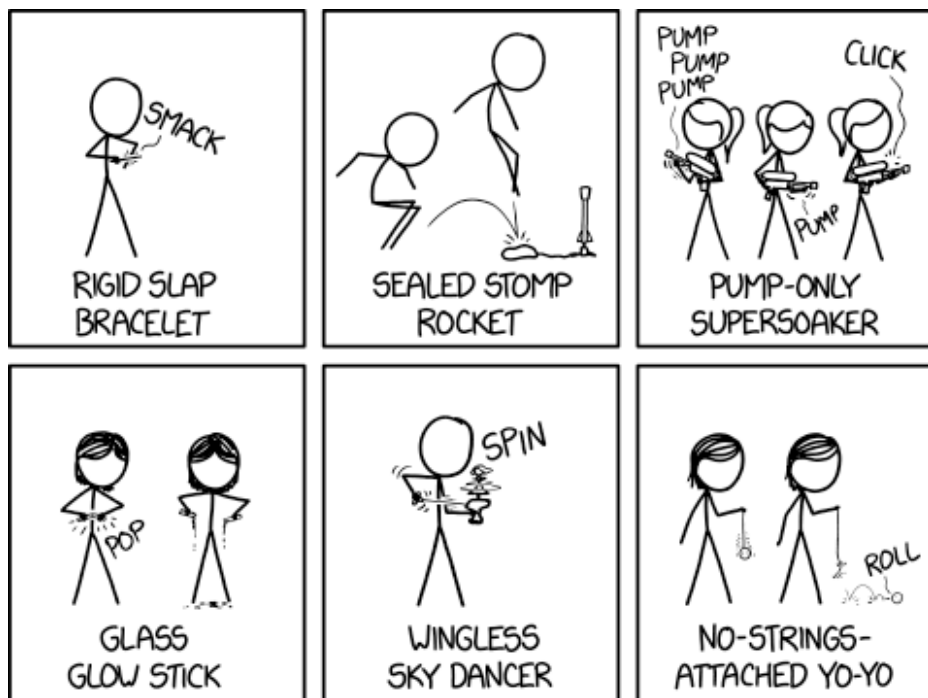
Since so many different models can fit this data set at first glance, Randall may be making a point about how if a data set is sufficiently messy, you can read any trend you want into it, and the trend that is chosen may say more about the researcher than about the data. This is a similar sentiment to 1725: Linear Regression, which also pokes fun at dubious trend lines on scatterplots.

A brief Google search reveals that Augustin-Louis Cauchy originally worked as a junior engineer in a managerial position. Upon his acceptance to the Académie des Sciences in March 1816, many of his peers expressed outrage. Despite his early work in "mere" engineering, Cauchy is widely regarded as one of the founding influences in the rigorous study of calculus & accompanying proofs. Notably, his later work included theoretical physics, and Lorentz was also a well-known physicist. Therefore, the title-text may be referring back to 793: Physicists.

Alternately, the title-text could be implying that the person who applied the Cauchy-Lorentz curve-fitting method may not be well qualified to the task assigned.

#2049: Unfulfilling Toys

September 21, 2018



MY LEAST SUCCESSFUL PRODUCT LINE WAS PROBABLY
"DEEPLY UNFULFILLING VERSIONS OF CLASSIC TOYS."

We were going to do a falling-apart Rubik's cube that was just 27 independent blocks stuck together with magnets, but then we realized it was actually really cool and even kind of worked, so we cut that one.

Explanation

This comic lists and illustrates six different classic toys that are missing a key piece or attribute that makes them work and/or that makes them unique or fun.

Slap bracelets are flexible curved strips of spring steel that roll up and become a bracelet when you slap them against your wrist. This function operates on the same principle and basic design as the rolled band of metal inside a tape measure. A rigid one would not twist and would be deeply frustrating and potentially painful.

A stomp rocket has a rubber pouch full of air, connected via a hose to a vertical cylinder contained snugly within the base of an air-propelled rocket. By stomping on the pouch, the air is forced out the top end of the cylinder, launching the rocket into the air. By sealing the air channel, the rocket would stay on the cylinder and the person would just be bounced into the air by the pouch — acting like the world's smallest bouncy house — or the pouch will burst, rendering the toy even more useless.

A Super SoakerTM is a brand of water gun that works by first pumping air into the gun, thereby introducing pressurized air above the water, then releasing the water using the gun's trigger — the extra pressure from the pumped air makes the water go much further than a traditional water gun which relies upon the pressure generated from a single pump of the trigger itself. In Randall's version, the water cannot be released, so the

fun part of the water gun – getting to spray your friends[citation needed] – isn't available.

In a classic glow stick, made of flexible plastic, one must first bend it enough to break the glass cylinder inside. This allows the chemicals inside to mix and begin glowing within the plastic tube. If the entire tube were made of actual glass, however, it would not only shatter into many sharp glass pieces but would also cover the hands of the unfortunate user with a mixture of mild but not harmless chemicals. Also, depending on this contraption's construction and/or luck, the chemicals either won't mix and not glow at all, defeating the purpose of the glow stick, or stain your hands, clothes, and surroundings with a glowing liquid, which would be rather unfortunate.

In the original toy, a doll or figure with folded-up wings sits on top of a hand-held device with a wrapped string or other mechanism that lets it spin the doll very fast. As the doll spins, centrifugal force causes the wings to unfold and provide lift, and the doll rises up in the air and flies, spinning, sometimes going quite high. Without the wings, the doll will spin but otherwise remain flightless.

In a traditional yo-yo, one attaches a string to their finger and the other end of the string is looped around the shaft of the yo-yo, in such a way that it will hold the yo-yo but the yo-yo can still spin. In this case, the string is presumably included but not attached to the yo-yo, so when the yo-yo reaches the end of its string it will fall off,

instead of coming back to the person or spinning at the end of the string.

Nonetheless off-string yo-yoing technique exists that has been a division of the World Yo-Yo Contest since 2003. The division specifies that the string is tied to one finger but not the yo-yo. It was popularized by yo-yo player Jon Gates. It differs from the manipulation of a Diabolo because the string is tied to one finger instead of being tied to two sticks. The return is accomplished with a twist of the string called a bind. Diabolos don't return. A good example is here at this video titled "Crazy Stringless Yoyo Tricks!".

Note that the phrase "no strings attached" is an idiom and usually refers to something being available without special conditions or restrictions, a favor being done with nothing expected in return, or a relationship intended to be very casual. In this case, it is literal rather than an idiom, in that the string that is normally attached to the yo-yo is literally not attached.

In order to build the magnetic Rubik's Cube, you would need to embed magnets in the inward-facing sides of each cube. This actually can be achieved by using a checkered pattern for the polarity of each piece, a single piece uses the same polarity at all its connecting sides while the immediate neighbor is configured in the opposite. This video shows the principle and even a working 5x5x5 magnetic cube.

Because such a cube doesn't fall apart Randall had to

remove it from his "deeply unfulfilling versions of classic toys."

It is also worth noting that although Randall said that there were 27 small magnetic cubes, only 26 small 'cubes' (or 'cubelets') appear in a traditional Rubik's cube, of three main types. There is no center block in a traditional Rubik's cube, instead there is a pivoting armature connecting the six face-centers (with just a single flat face) together while allowing their individual rotation, each of which can keep the 12 edge-centers (two externally-flat faces) rotatably-anchored to at least one face at a time by a form of dovetailed tab on those edge pieces and, similarly, those hold the eight corners (with three outer faces) in place even as they follow a single face's rotation primarily held by the two most currently relevant of the adjacent edges.

It might also refer to various square-shaped neodymium magnet-based toys, like this one or this one, which although they can be taken easily apart, they are successful and very fulfilling products on their own.

#2050: 6/6 Time

September 24, 2018

UNDER MY TIME SYSTEM, THE SUN RISES AT 6 AM AND IT SETS AT 6 PM, AS IT *SHOULD*.

THE LENGTH OF THE SECOND IS DIFFERENT EACH DAY AND NIGHT, AND THE CURRENT TIME SHIFTS WITH YOUR LATITUDE AND LONGITUDE.

TODAY IS ONE OF THE TWO DAYS EACH YEAR WHEN MY CLOCKS RUN AT THE SAME SPEED AS EVERYONE ELSE'S.



TIME STANDARDS ARE SO UNFIXABLY MESSY AND COMPLICATED THAT AT THIS POINT MY IMPULSE IS JUST TO TRY TO MAKE THEM WORSE.

You know how Einstein figured out that the speed of light was constant, and everything else had to change for consistency? My theory is like his, except not smart or good.

Explanation

Cueball suggests a regional time system similar to that used in many societies prior to the invention of mechanical time keeping, such as Japan during the Edo period or the Roman Empire, where the day is separated into two parts based on night and day and then subdivided by hour, minute, and second to give season-variable lengths for each. This method is also named temporal hour, and still in use in the Jewish religion time table.

Midpoints in time such as noon and midnight vary on the longitude from east and west, while the length of day and night depends on the latitude. The first problem is solved today by using time zones in which at noon the sun is in most cases at or close to the zenith and sunrise/sunset happens at different times. The second issue is attributed to the tilt of Earth's axis and the curvature of its surface; in summer days are longer than nights and vice versa in winter. In the polar regions, there are very long days (and nights) and by Cueball's suggestion the entire months-long polar day would last only 12 of the newly defined "hours".

The caption lays out the punchline in which Randall has very strong feelings and opinions on how standards of time should be measured (his feelings on Daylight Savings Time have been well-documented in other comics), but as bad as he believes the official standards are he also recognizes that his own rules would not be

popular with other people. After coming to recognize this he has made a hobby or game out of making the worst possible system of measuring time and sharing it with other people.

The caption, though vague, can also be assumed to relate to the gradual deviation of certain regions from the Coordinated Universal Time (UTC) zones with "Daylight Saving Time" that is observed inconsistently and smaller regions opting for awkward fractional increments of deviation from Coordinated Universal Time.

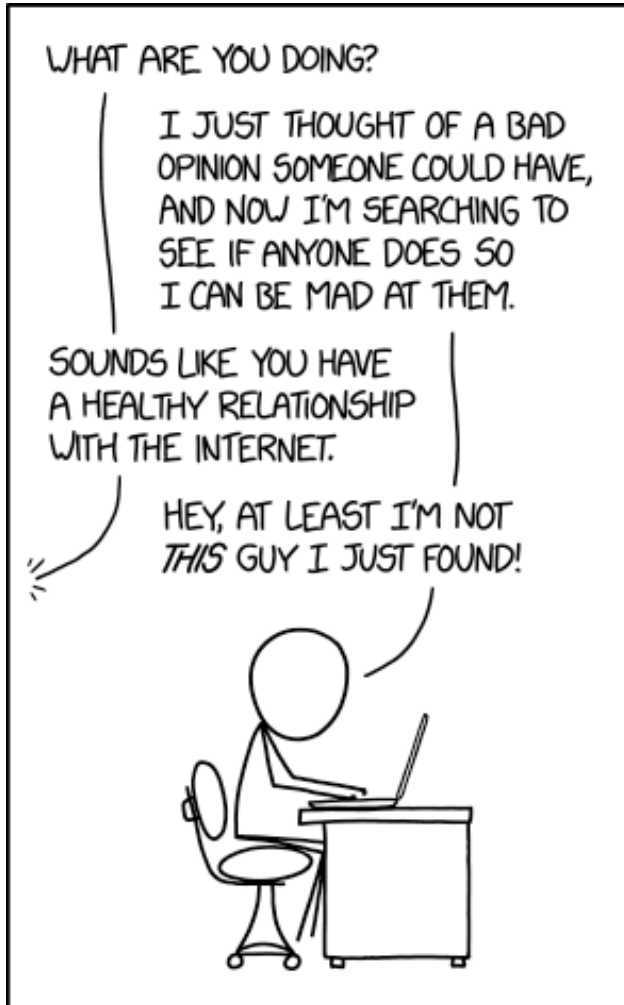
The title text refers to Einstein's special theory of relativity which postulates that the speed of light is the same for all observers, regardless of the motion of the light source (or the observers). An observer at high speed measures the same speed of light as an observer with no motion, measured from the same light source. In classical physics, the speed of the moving observer would be added up, but in special relativity, this isn't true. Instead, the time runs slower for the moving observer. Additionally to this time dilation, there is also a length contraction, without which the geometry wouldn't work.

"Today is one of the two days each year when my clocks run at the same speed as everyone else's" refers to the autumnal and vernal equinoxes when day and night are the same lengths, therefore causing his clocks to match the world. The comic was released one day after that year's September equinox, which would be the autumnal

equinox for Randall.

#2051: Bad Opinions

September 26, 2018



I thought of another bad opinion! I couldn't find anyone who expressed it specifically, but still, the fact that I can so easily imagine it is infuriating! I'm gonna tell everyone about it!

Explanation

Cueball is imagining bad opinions, searching them up on the Internet, and becoming angry with the people holding said opinions. An offscreen character, upon learning about this, sarcastically remarks that this indicates a "healthy relationship with the internet." Of course, if Cueball wasn't thinking of all these bad opinions, they most likely wouldn't have come to his attention, and he wouldn't have an opportunity to be mad about them. The fact that Cueball is the cause of his own agitation is the joke of (or perhaps, the sad part of) the comic. Cueball misses the offscreen character's point and remarks that he's not as bad as some person he has discovered, presumably through the aforementioned method of searching for bad opinions he thinks up.

In title text he goes further, where he can't find an opinion he imagined on the internet, but still wants to discredit it, just because he is so infuriated by just being able to imagine it. This is similar to straw man fallacy, where someone attempts to discredit an opponent by misrepresenting their argument, rather than addressing their real point.

Ironically, the comic itself could potentially be considered an example of this kind of behavior. It is possible that Randall imagined the absurd person and behavior depicted in the comic, and wrote a comic satirizing it, without knowing if such a person actually exists.

The unhealthy conversation habits enabled by the Interblag has been a regular theme in xkcd. In fact, this is a rather obvious callback to one of the most popular xkcd comics, 386: Duty Calls, wherein Cueball is actively seeking to discredit and correct people who are "wrong" on the internet. This is later done in 2071: Indirect Detection.

Perhaps due to the inherent combination of disconnection and intense focus involved in use of the internet, it's pretty common for people to get into arguments online. Cueball has followed the trend of finding social success online by dedicating more time and energy to arguing pedantic points than his opponents. He's done this to such a great degree that he is now actively seeking possible arguments, even when the situations do not arise on their own. The end result is that his life has needlessly more stress, his interpersonal habits are those of contradiction and conflict, he makes unnecessary enemies, and he is always looking at a computer screen instead of his real world friends.

#2052: Stanislav Petrov Day

September 28, 2018



I was going to get you an alarm clock that occasionally goes off randomly in the middle of the night, but you can ignore it and go back to sleep and it's fine.

Explanation

Stanislav Yevgrafovich Petrov was a lieutenant colonel of the Soviet Air Defence Forces who became known as "the man who single-handedly saved the world from nuclear war" for his role in the 1983 Soviet nuclear false alarm incident. The incident was unknown to the public until it was revealed shortly before the dissolution of the Soviet Union in 1991.

On 26 September 1983, during the Cold War, the satellite-based early-warning system of the Soviet Union reported the launch of multiple intercontinental ballistic missiles from the United States. At the time, tensions with the U.S. were on edge, and high officials of the Soviet Union, including General Secretary Yuri Andropov, were thought to be highly suspicious of a U.S. attack.

Petrov checked ground-based radars which had not detected a launch, noted that the warning system had detected only 1-5 missiles instead of the hundreds that would have been expected in the event of a first strike, and chose to mark the system alert as a false alarm. This decision is seen as having prevented a retaliatory nuclear attack, which would have probably resulted in immediate escalation of the Cold War stalemate to a full-scale nuclear war and the deaths of hundreds of millions of people. Investigation of the satellite warning system later confirmed that the system had indeed malfunctioned.

While it is highly probable that if Petrov had reported this incident to his superiors they would have come to the same conclusion, it was a point in time when many people feared that the Cold War might become hot. Andropov, the new Soviet leader, was considered weak by the US president Ronald Reagan, and the Western countries were deploying new missile installation in Europe to counter existing missiles in the Eastern Bloc. This fear of nuclear war meant that at this time the peace movement in most western countries reached one of its highest levels.

In this comic Cueball reacts to his alert on Stanislav Petrov Day as if it was a false alarm. This is of course a truly ironic since what we celebrate is that Stanislav treated an alert as a false alarm. Also his first comment "Oh shoot" could have been the reaction of Stanislav if he had not assumed it was a false alarm.

In real life, many alerts reach everybody on their mobile devices, often causing them to be ignored without deeper knowledge about the issue behind. This was however not the point in this comic.

The title text presents a much less important false alarm where one of them, probably Cueball (or perhaps Randall), was thinking about giving a gift to the other one in the form of an alarm clock that alerts randomly in the middle of the night. That particular alarm is one where she or he can just breathe a sigh of relief and go back to sleep because it's not a real alarm and is perfectly safe to ignore. However if this keeps going off when it's

not supposed to, then when you are actually supposed to wake up you may very well end up assuming that it's another false alarm, and thus will sleep late anyway, completely defeating the point of the alarm. Also when a real alarm is supposed to wake you up in the middle of the night, you will have been trained to ignore alarms. This is all part of the joke.

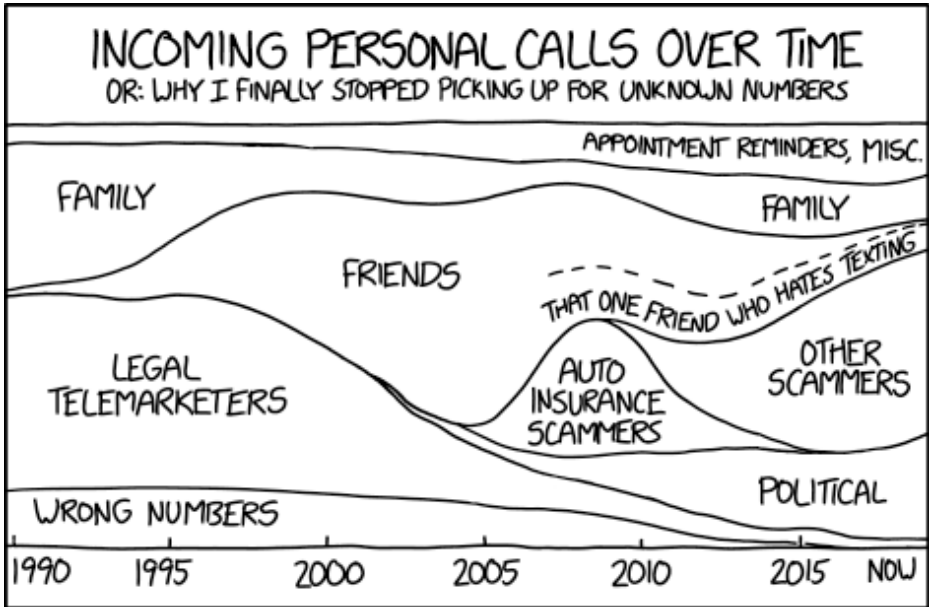
On the 2007 anniversary, Eliezer Yudkowsky wrote a blog post for LessWrong suggesting that "Wherever you are, whatever you're doing, take a minute to not destroy the world." Not destroying the world has since evolved into an annual tradition. There is a website for the holiday, with several variations of a ritual involving lighting and snuffing candles. The intended mood is that of a somber holiday, somewhere between Thanksgiving and a funeral.

However, there are also more lighthearted takes. A "hardcore mode" would be just like the normal holiday, but "During said ceremony, unveil a large red button. If anybody presses the button, the ceremony is over. Go home. Do not speak." Alternatively, "you use a website connected to *another* house where people are also celebrating Petrov Day. If anyone in one house presses the button, the other house receives a launch alarm. They have 60 seconds to respond. At the end of 60 seconds, their party is over, and they must go home silently. The website has some chance of giving you a false alarm." The website can be found here with instructions on how to use it here.

Stanislav Petrov himself died in 2017, but in 2018 the Future of Life Institute decided to award his surviving family a \$50,000 prize for his contributions. However, in the words of MIT Professor Max Tegmark, who presented the award, the fact that Petrov's son couldn't "get a visa to visit the city his dad saved from nuclear annihilation is emblematic of how frosty US-Russian relations have gotten, which increases the risk of accidental nuclear war."

#2053: Incoming Calls

October 01, 2018



I wonder if that friendly lady ever fixed the problem she was having with her headset.

Explanation

This comic shows a graph (a 100% stacked area chart) of incoming phone calls over time to Randall since he was older than six years. Not covered are major modern ways to communicate like SMS, talking on Facebook, or other messaging apps.

Wrong numbers used to be a small but significant portion of the phone calls that Randall received and remained fairly steady until the late 1990s, when they began a gradual and accelerating decline, eventually tapering off to nearly none in 2015. This is likely due to the rise of cellphones and programmable land-line phones, which contain their own address books and only require the caller to enter the number once, greatly reducing the chances of accidentally entering a wrong number in general and eliminating the possibility entirely for anyone with whom you have taken the time to save their number.

Appointment reminders and miscellaneous similar calls have steadily increased with time, likely due to a combination of Randall's increasing responsibilities as he ages, and thus the number of appointments and legitimate businesses who need to contact him, and the increased use by businesses of automated reminder systems. The appointments section seems to be slightly tapering off, possibly for the rise of using other means, such as SMS, for reminders.

The proportion of family members started slowly decreasing until 1998 where it remained almost constant until roughly 2008-2009. Possible reasons for the decline is that Randall's family has been passing away from old age, or that Randall has ceased contact with them; a possible reason for the increase thereafter is Randall's meeting of his current wife, thus gaining in-laws.

A note to keep in mind though is that the graph represents the relative percentage of calls, not the absolute number; therefore, a third possibility is simply that the number of calls hadn't changed, but rather the volume of phone calls from everyone else has gone up. Likewise, the increase in phone calls from family might simply be due to the number of phone calls from everyone else going down while family calls have remained constant. Additionally, as mentioned below, phone communication may be decreasing due to the rise of other communication mediums.

The proportion of friends who call Randall rapidly increased in the 1990s and began to overtake family, likely due to a combination of gaining new friends over time and old friends growing into teenage years owning a cell phone roughly starting in the 2000s. At that time the Internet wasn't a primary method of communication especially when away from home, thus phone calls were the main way to connect with friends when apart. Over time, Randall's friends and family have been less likely to make phone calls to him, likely as phone calls have been succeeded by other methods of communication. This is supported by an entry for "that one friend who hates

texting" which has grown to encompass pretty much the entire "Friends" category; presumably all his friends EXCEPT that "one friend" do all their communicating with Randall by text or other chat services.

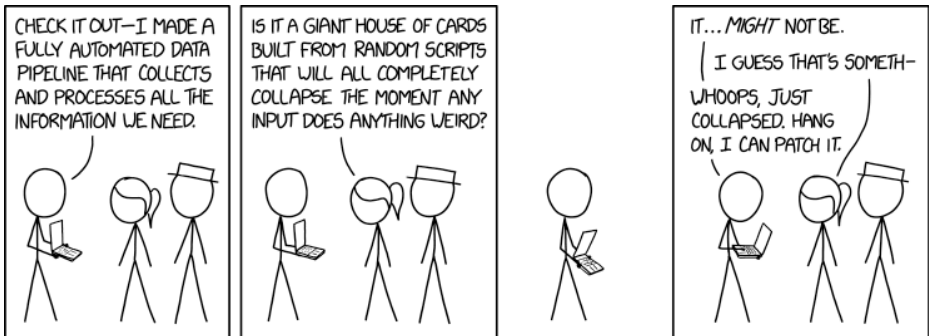
Additionally, although there was a large percentage of phone calls from legal telemarketers in the 1990s, this percentage has significantly dropped, perhaps due to the National Do Not Call Registry in the United States, which prohibits telemarketing/automatic dialing to those on the list. Political advertisements are exempt from this list. Instead, there has been a rise in phone calls from scammers and political advertisements.

Telemarketers may target calls based on victims' age or other publicly available statistics. The rise and fall of auto insurance scammers may indicate targeting people in their early twenties. It could also be tied to other events, such as the purchase of an automobile. There have also been various reports online about the commonality of this scam in and around 2013, () indicating this may have been a particularly challenging problem during this period.

The title text refers to a common scamming tactic in which a robocaller, typically one named "Emily," will claim to be having trouble with their headset and say "Can you hear me now?" The trick is either to keep you on the line while taking a second or two to connect you to a real person to get scammed, or to get a recording of you saying "yes" for potential fraudulent use (or both).

#2054: Data Pipeline

October 03, 2018



"Is the pipeline literally running from your laptop?" "Don't be silly, my laptop disconnects far too often to host a service we rely on. It's running on my phone."

Explanation

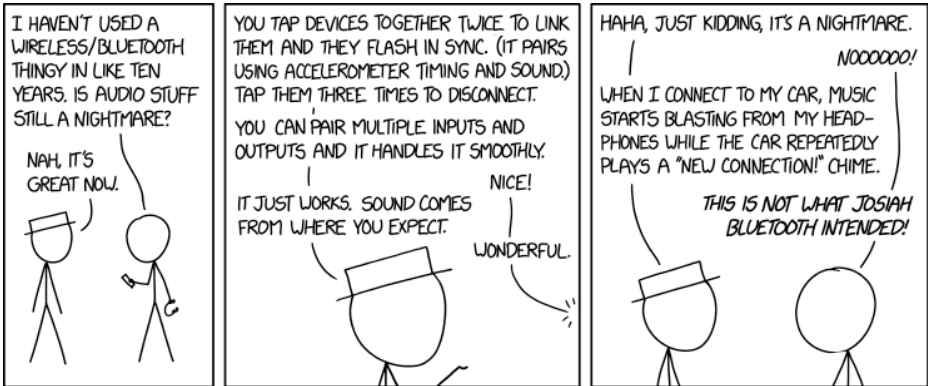
In the first panel Cueball shows Ponytail and White Hat a Data Pipeline he has constructed that, as he puts it, 'collects and processes all the data we need'. This implies that the three are running some sort of project that requires data processing. Ponytail assumes that this data pipeline is an unstable mess of scripts that will cease to function correctly should any unexpected input be received. Cueball tries to claim it isn't, but his hesitation (including using the word "might") essentially states that this is very likely, although he seems to hope that it might not be. Ponytail then seems impressed and expresses this to him. She, however, gets interrupted by Cueball who tells her that the system just malfunctioned and collapsed. He, however, states that he can fix it, making it seem like this cycle of patching and collapsing could repeat infinitely, or until all problems have been patched. Knowing Cueball's code, though, it seems more likely he can't patch it.

In the title text, Ponytail or White Hat proceeds to question how such an important system can run on such a small computer. However, Cueball makes it worse by saying he uses his phone due to the better connection. While this might give the pipeline more uptime, it also means its system resources are far more limited.

Cueball's hesitant response in this comic has some similarities to 410: Math Paper.

#2055: Bluetooth

October 05, 2018



Bluetooth is actually named for the tenth-century Viking king Harald "Bluetooth" Gormsson, but the protocol developed by Harald was a wireless charging standard unrelated to the modern Bluetooth except by name.

Explanation

Bluetooth is a technology invented in the mid 1990s and intended for devices to connect wirelessly over a relatively short range for the purpose of transmitting information and/or audio. For example, a headset that connects via Bluetooth could be connected to a computer that's also Bluetooth-enabled, and then whatever would normally come out of the computer's speakers would come out the headset's ear pieces instead, and whatever was spoken into the headset's microphone would be transmitted to the computer's audio input system as if coming in through the computer's microphone. For this to work, the two devices need to be paired, which means they need to know the unique identification number of the other device and have been given permission to communicate with it, as well as knowing what kind of data exchanges are both possible and allowed. Pairing is not always a smooth process, especially given the somewhat limited methods some of these devices have for user interaction. For example, headsets typically don't have screens and user interfaces that make it easy to select what computer or other device you want them to connect to, so you're often confronted by blinking lights and/or sounds to make it through the pairing process, with each device having its own method for initiating or accepting a pairing request.

Cueball is talking to White Hat about Bluetooth and wireless connectivity. He asks if it has become easier to stream audio via Bluetooth since he last used it. White

Hat then jests that it has become an easy-to-use and streamlined service, where connecting devices is easy, and he gives some examples of how easy it is to use. Cueball is excited about this, until White Hat reveals that he was lying and that Bluetooth is still as hard to use as ever. Cueball then invokes the name of "Josiah Bluetooth", a fictitious person implied to have invented the eponymous Bluetooth. "Josiah" is an old-timey name particularly given to many possibly notable individuals, especially in the 18th and 19th centuries, and suggests the amusing idea that in the 1700s or 1800s a hardy inventor named Josiah Bluetooth came up with the idea for wireless audio. (Note that while there is no "Josiah Bluetooth" person, there is a "Josiah" Bluetooth ceramic speaker.)

This comic also references the common problem of audio playing through the wrong device when Bluetooth is activated.

The title text is another misdirection joke because while the first part of the sentence is true (Bluetooth was indeed named after a tenth-century Viking king), it goes on to make the silly claim that King Harald himself developed a wireless charging standard. This is a reference to the Qi wireless power transfer standard that, like Bluetooth, is a well-branded industry standard with a catchy name and wide adoption that also does not work quite as well as promised even 10 years after its first release. (It could also be a reference to Medieval Vikings charging into battle, which is, by most accounts, usually a fairly wireless affair[citation needed] (assuming one

discounts chainmail armor). In this case, the standard could be a pun as a standard also denotes a royal or military flag.)

Specifically, the Viking king referenced in the title text, Harald “Bluetooth” Gormsson, usually called Harald Bluetooth, was a ruler of Denmark and Norway who died in 985 or 986. Jim Kardach of Intel named the Bluetooth protocol after him, apparently as he united the various Norse tribes of Denmark into a single kingdom just as Bluetooth unites communication protocols. The Bluetooth logo unites the two Norse runes corresponding to “H” and “B” for Harald Bluetooth.

#2056: Horror Movies

October 08, 2018



"Isn't the original Jurassic Park your favorite movie of all time?" "Yes, but that's because I like dinosaurs and I **WANT** there to be an island full of them. If John Hammond's lab had been breeding serial killers in creepy masks, I wouldn't

have watched!" "Wait, are you sure? That could actually be good." "Ok, I **WOULD** watch the scenes where Jeff Goldblum tries to convince a bunch of executives that the park is a bad idea."

Explanation

This comic is the first in the Horror Movies series, which was followed by 2076: Horror Movies 2 a month later.

Horror movies are a genre of movie or film which generally center around eliciting fear in the viewer. Such films have gone through cycles of rising and falling popularity, and were particularly popular at this time of this strip's release.

When White Hat suggest watching such a movie, Cueball sarcastically responds "sure! I love watching terrible things happen to people and feeling afraid!" This presumably reflects the reasons why Cueball is uninterested in watching horror films, and why he finds the appeal incomprehensible. The caption reveals that this is also true of Randall.

The emotional response of fear, by its nature, tends to repel people. The biological purpose of the fear response is to signal that you are in danger, and should find a way out of the situation. Accordingly, the fact that people would deliberately seek out (and remain in) situations that they're afraid of is counterintuitive. Nonetheless, there are many activities which are pursued for entertainment which are specifically designed to trigger a fear response. The reasons for this are varied and speculative. The emotion of fear, and its accompanying physical responses (racing pulse, rapid breath, adrenaline release) are appealing and thrilling to some. Experiencing

the response without facing genuine danger allows people to experience and explore fear in a safe environment. For some people, this might have a cathartic effect, giving them control over the release of their emotions. For some, it could act as a form of exposure therapy, allowing them to reduce exaggerated fear responses. Others take a more detached view and enjoy watching bad things happen to other people, perhaps deriving humor or enjoyment out of a situation that they are glad not to be in themselves (and with the additional protection of knowing that the events aren't real).

Neither Cueball nor Randall seem to connect with any of the things that make horror films appealing to some, and experience it only as a negative and revulsive experience. As a result, both are entirely uninterested in seeking them out as entertainment.

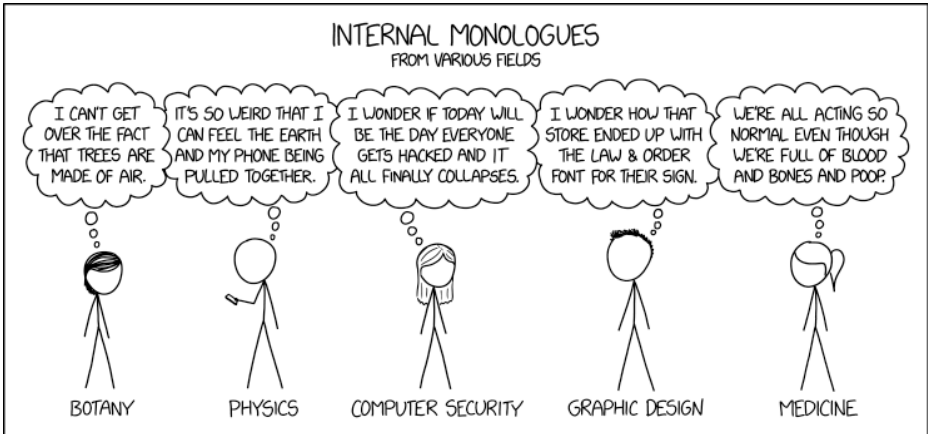
The title text continues the conversation. White Hat points out that Cueball's favorite movie is Jurassic Park. This movie could be considered a "horror" film, since a significant portion of the film consists of people fleeing in terror and trying to survive as dinosaurs hunt and kill them. Randall makes the distinction that he likes dinosaurs and wants there to be an island full of them, hence, rather than being a source of fear, he sees the narrative as something appealing. He says that if the company in the film had been breeding "serial killers in creepy masks", he wouldn't have watched. The implication is that people being hunted by serial killers is revulsive to him, but people being hunted by dinosaurs is

not (implicitly because he sympathizes with the dinosaurs more than with the people).

The conversation then goes off the rails a bit, as White Hat argues that the plot Cueball suggests "could actually be good". The notion of a lab specifically breeding serial killers might make for a viable horror movie, but Cueball has expressed his dislike for the genre, and replies that he'd only watch the scene where Jeff Goldblum tries to convince executives that it's a bad idea. An early scene in Jurassic Park has Ian Malcolm, played by Jeff Goldblum, trying (unsuccessfully) to convince the executives of the park that breeding dinosaurs in the modern age is an incredibly dangerous notion, since the outcomes are impossible to predict, and no safety measures can account for all the possible outcomes. The joke is that the notion of breeding serial killers for an amusement park is even more obviously terrible than breeding dinosaurs, and the idea of watching the same character trying to make that case (and presumably being ignored) is appealing to Cueball, even if the rest of the movie wouldn't be.

#2057: Internal Monologues

October 10, 2018



Haha, just kidding, everyone's already been hacked. I wonder if today's the day we find out about it.

Explanation

This comic explores some seemingly strange perspectives that academics or professionals might have due to their deeper knowledge and understanding of the fields that they study.

Many seemingly mundane phenomena can actually be quite weird or counterintuitive if you understand how they really work. The five people featured in this comic, all from different disciplines, are all aware of certain facts about reality that seem so strange even they have trouble believing they are true; yet, undeniably, they are.

- Megan, a botanist, is struck by the fact that trees are made in large part from air, as in the carbon dioxide they consume.
- Cueball, a physicist, finds it weird that he can feel the gravity between an object in his hand (his phone) and the Earth. This is literally just the weight of the phone.
- Blondie, a computer security researcher, knows of the inherent insecurity of computer systems and wonders if today is the day everyone will get hacked, collapsing our society.
- Hairy, a graphic designer, wonders what sequence of events drove a store's decision to use a particular recognizable font for their signage.
- Ponytail, studying medicine, wonders how humans manage to seem so normal on the outside, given that most of their bodies are made up of things usually

unmentionable.

Four of the five people are pondering things that they happen to find very interesting but that aren't too concerning to an everyday person, whereas what Blondie is pondering could have widespread or even global effects on our way of life. In the title text, Blondie amends her thought, since she actually knows an even more concerning truth: we've already all been hacked, and we just don't know it yet.

Below, the people's thoughts are explained in detail.

Almost the entire mass of a tree is made of atoms which are extracted from the air. Trees (like all photosynthetic plants) grow by extracting carbon dioxide from the air and water and nutrients from the soil and chemically recombining the atoms to form large, organic molecules (such as cellulose) which is then used to build the their structure. In this sense, trees can be said to be "made of" air and water. And since the water generally comes from rain which condensed from water vapor in the air, that means that air contains nearly everything that's used to form a tree's structure.

This is counterintuitive, since trees are generally heavy, dense and solid objects, which seem fundamentally different from the air around us, which we often don't even notice. But such conversion between different types of matter is common in chemistry.

Gravity is the weakest of the four fundamental forces in physics but also to humans the most preeminent one. In

everyday experience, most people tend to think of gravity merely as a pervasive downward force, but as a physicist, Cueball is more aware that in fact, all gravitational forces are mutual; any pair of objects will exert a gravitational force on each other, regardless of how big they are. Therefore, when he feels the weight of the phone in his hand, he understands that what he's actually feeling is the net attractive force between the phone and the planet, both of them pulling towards the other with enough force that a human can easily detect it.

Anyone well versed in computer security understands just how insecure the systems that we depend on actually are.

In the title text it is noted that possibly all our systems are already hacked, and we just haven't found out yet. Since malicious hackers do their work covertly, a successful hack often isn't discovered until days, weeks, or even years later if at all. By that time they may have successfully hacked many other systems using the same techniques and/or exploiting the same widely unknown or un-patched security flaws. Some high profile hacks recently discovered at the time of this posting include a 50-million user hack of Facebook and Google+ announcing they are shutting down the consumer side of Google+, in part due to a security flaw that was discovered and patched months ago.

Graphic designers recognize fonts and design elements, and see how they come together. In this comic, the graphic designer wonders how the Law & Order font was

chosen for a particular storefront's sign. Law & Order is a police procedural TV series created by Dick Wolf in 1990, which has had various spinoffs. The font used for the title sequence of Law & Order is called Friz Quadrata, and is also the font used for the signage of the New York Police Department headquarters.

Doctors are well versed in human anatomy, and are likely to think about what is inside of people more than the average person would. The things that are inside our bodies tend to cause a visceral reaction when we're exposed to them. As a result, most people tend not to think about them most of the time, and think of people in the terms that we're used to: seeing and experiencing only the exterior. Most people are aware, in theory, that blood, bones, feces, and other things that we find disgusting, are inside us (and the people around us), but very rarely connect that reality with our everyday reactions to them.

Doctors are not only particularly familiar with what goes on inside people, but likely have to deal with it on a regular basis, and may have to frequently see what's going on inside people. In consequence, it may be harder for them to ignore the biological reality of the people around them, as they're intimately familiar of what's going on inside everyone at any given time.

#2058: Rock Wall

October 12, 2018

I LIVE NEXT TO A WALL OF ROCK 20 MILES THICK. THERE'S NO WAY AROUND OR OVER IT. I'M TRAPPED ON THIS SIDE FOREVER.

I STUDY THE STUFF ON THE OTHER SIDE.



MANTLE GEOLOGY SEEMS LIKE
THE MOST FRUSTRATING FIELD.

I don't trust mantle/core geologists because I suspect that, if they ever get a chance to peel away the Earth's crust, they'll do it in a heartbeat.

Explanation

Mantle geologists study that part of the planet that's below the top "crust" of the planet. The top layer of the planet, which is several dozen miles thick, is the only layer we've been able to explore, by digging tunnels, spelunking, etc. The only way to study the mantle and other inner layers of the earth are through non-visual, non-tactile, indirect methods, and by analyzing old samples of the mantle that have made their way to the surface.

In this comic, Ponytail, talking to Megan, is describing her job as a mantle geologist as that of living on one side of a thick wall that is, and likely always will be, impossible to get around, but she has to study what is on the other side of the wall. In this case the wall is horizontal rather than vertical, the wall being the earth's crust, and makes a complete sphere, so the only way to get past the wall would be to go through. It is theoretically possible to go through, but as of the comic's posting, humanity is far from doing so. (The deepest hole dug as of at that time, as measured by true vertical depth, is the Kola Borehole, which only goes down to 12,262 meters out of the estimated 35,000 meters needed to get through at that location.)

In the title text Randall states that he doesn't trust mantle/core geologists. Because if they got the chance he believes they would not hesitate (even the duration of a heartbeat) to strip away Earth's crust to study the mantle

or even worse the core directly. Of course if they only did this locally to look at the mantle it would not shatter the Earth although that local area may become a volcano. But if they actually peeled the entire outer layer away, we humans would have no place to live, as the mantle is really hot[citation needed] and would melt easily (producing magmas and therefore lavas when magma's exposed to surface, see title text of 1405: Meteor to be more confused). However, after a while all these erupted lavas would solidify and become a new crust. Humanity needs to withstand just some millennia of active worldwide volcanism.

But Randall is afraid that their craving to get around that 20 mile wall would prevent the researchers from even hesitating if they did get that chance. Fortunately, we can study planetary cores in the solar system without stripping Earth's surface by visiting an asteroid which is thought to be the exposed iron core of a protoplanet. The Psyche mission launched in 2023 and is scheduled to arrive at 16 Psyche in 2029.

This comics seems to be a spin-off from the previous comic 2057: Internal Monologues, where Randall tried to find some interesting monologues from scientist from different research fields. Maybe he did not find an internal monologue he liked for geologists, but ended up with this idea instead. Thinking about the core or mantle, lava and magma seems to be something Randall does a lot, and thus he must have some ideas about how a geologist would think, as in 913: Core.

The situation of peeling off the outer layers of the Earth has been addressed in more detail in the "Lose Weight the Slow and Incredibly Difficult Way" chapter of What If? 2.

#2059: Modified Bayes' Theorem

October 15, 2018

MODIFIED BAYES' THEOREM:

$$P(H|X) = P(H) \times \left(1 + P(C) \times \left(\frac{P(X|H)}{P(X)} - 1 \right) \right)$$

H: HYPOTHESIS

X: OBSERVATION

P(H): PRIOR PROBABILITY THAT H IS TRUE

P(X): PRIOR PROBABILITY OF OBSERVING X

P(C): PROBABILITY THAT YOU'RE USING
BAYESIAN STATISTICS CORRECTLY

Don't forget to add another term for "probability that the Modified Bayes' Theorem is correct."

Explanation

Bayes' Theorem is an equation in statistics that gives the probability of a given hypothesis accounting not only for a single experiment or observation but also for your existing knowledge about the hypothesis, i.e. its prior probability. Randall's modified form of the equation also purports to account for the probability that you are indeed applying Bayes' Theorem itself correctly by including that as a term in the equation.

Bayes' theorem is:

The purpose of Bayesian inference is to discover something we want to know (how likely is it that our explanation is correct given the evidence we've seen) by mathematically expressing it in terms of things we can find out: how likely are our observations, how likely is our hypothesis a priori, and how likely are we to see the observations we've seen assuming our hypothesis is true. A Bayesian learning system will iterate over available observations, each time using the likelihood of new observations to update its priors (beliefs) with the hope that, after seeing enough data points, the prior and posterior will converge to a single model.

The probability always has a value between zero and one, the latter value represents a 100% probability. Both extremes would be:

- If $P(C)=1$ the modified theorem reverts to the original

Bayes' theorem (which makes sense, as a probability one would mean certainty that you are using Bayes' theorem correctly).

- If $P(C)=0$ the modified theorem becomes $P(H | X) = P(H)$, which says that the belief in your hypothesis is not affected by the result of the observation.

It is a linear-interpolated weighted average of the belief from before the calculation and the belief after applying the theorem correctly. This goes smoothly from not believing the calculation at all up to be fully convinced to it.

Bayesian statistics is often contrasted with "frequentist" statistics. For a frequentist, probability is defined as the limit of the relative frequency after a large number of trials. So to a frequentist the notion of "Probability that you are using Bayesian Statistics correctly" is meaningless: One cannot do repeated trials, even in principle. A Bayesian considers probability to be a quantification of personal belief, and so concepts such as "Probability that you are using Bayesian Statistics correctly" is meaningful. However since the value of such subjective prior probabilities cannot be independently determined, the value of $P(H|X)$ cannot be objectively found.

The title text suggests that an additional term should be added for the probability that the Modified Bayes Theorem is correct. But that's this equation, so it would make the formula self-referential, unless we call the result the Modified Modified Bayes Theorem. It could also result in an infinite regress -- needing another term for

the probability that the version with the probability added is correct, and another term for that version, and so on. If the modifications have a limit, then a Modified ω Bayes Theorem would be the result, but then another term for whether it's correct is needed, leading to the Modified $\omega+1$ Bayes Theorem, and so on through every ordinal number.

Modified theories are often suggested in science when the measurements doesn't fit the original theory. An example is the Modified Newtonian dynamics theory, among many others, in which some physicists try to explain dark matter with not much success.

#2060: Hygrometer

October 17, 2018



FOR SOME REASON, I FEEL
A POWERFUL COMPULSION
TO OWN ANY DEVICE WHOSE
NAME ENDS IN "-OMETER."

I'm working on assembling a combination declinometer, sclerometer, viscometer, aleurometer, stalagmometer, and hypsometer. I'm making good progress according to my ometerometer, a device which shows the rate at which I'm

acquiring measurement devices.

Explanation

Here, Megan is talking to Cueball about hygrometers. But before she can even finish explaining what it does, Cueball has looked up, found, and purchased the product. A hygrometer is an instrument for measuring the amount of water vapor in the atmosphere, or the amount of water in solids such as soil or wood.

It seems Randall (or Cueball) loves being able to measure things and therefore finds instruments or measurement tools that end in -ometer very interesting, and wishes to own all of them. Many measuring instruments use the suffix -meter which is derived from the Greek noun μέτρον for "measure". The character "o" always belongs to the first term, but it also belongs to old Greek words like Thermo-meter, micro-meter, or even hygro-meter. Other measurement devices such as speedometer use an English word with an "o" appended to mimic the Greek-derived terms, purportedly for easier marketing. Because themes in science often based on Greek terminology that ending at the first part appears often. Nonetheless, Randall believes that this "o" belongs to the general term for measuring devices.

In the title text, Randall states he is working on assembling a combination of usually unrelated measuring instruments, for a purpose that is neither stated in the comic nor easy to guess. The list consists of:

- A declinometer is an instrument to measure magnetic

declination.

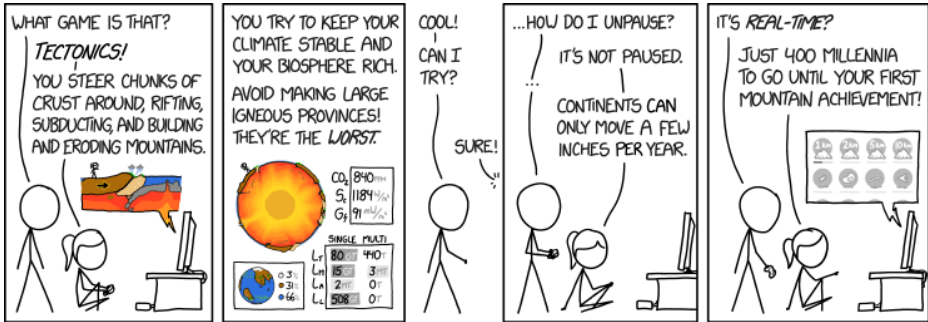
- A sclerometer is an instrument to measure scratch hardness of a solid by scratching it under some standard conditions and measuring the scratch. Instruments used to measure the elastic properties of concrete surfaces, like the Schmidt hammer, are also often known as sclerometers.
- A viscometer is an instrument to test the viscosity (difficulty of pouring) of a liquid. For example, honey has a higher viscosity than water.
- An aleurometer is an instrument to evaluate the quality of flour for baking by measuring how much a wet mass of wheat can expand when warmed while keeping its adhesivity.
- A stalagmometer is an instrument to measure surface tension of fluids by producing a drop and weighing it - the bigger the drop is, the larger surface tension the fluid has.
- The word hypsometer could refer to either of two unrelated instruments to measure height. One measures heights of a building or a tree by triangulation. The other measures altitude by measuring air pressure through its effect on the boiling temperature of water. It should not be confused with the altimeter which measures altitude by mechanically measuring air pressure (and which also does not follow the -ometer rule and might, therefore, be of less interest to Cueball(?))

Finally, he mentions an ometerometer, a concatenation

of -ometer with itself, which would be a device for measuring devices. It has been included in a humorous list of Other Types of Ometers from 2007, where it was described as measuring the measuring capacities of other measuring devices.

#2061: Tectonics Game

October 19, 2018



They're limiting the playtesters to type A3 V stars, so the games will all end before the Sun consumes the Earth.

Explanation

This comic is to show similarity to many simulation games, which have various niche popularity. Similar to Maxis' Spore, the game in question allows you to terraform entire worlds. However, in a typical Randall twist, unlike most simulation games, you could not speed up the progress of time to make world-changing endeavours occur in a matter of seconds. The game operates in real time, which means most of the user time-frame will be spent idly watching nearly non-moving continents drifting at the real speed of continental drift, a couple of inches a year, which makes for very slow gameplay. Thus several hundred millennia of play time is needed to reach a game achievement of forming a kilometer high mountain.

Many computer games simulate to one degree or another real items and tasks, but often simplify them to fit into a game format -- to make them more exciting, to make them quicker, to advance a particular plot line or quest, etc. For example, a game about farming might allow you to grow corn, but whereas in real life corn takes about 90 days to germinate from seed and grow to maturity, in a game the growth might be instantaneous or measured by minutes, rather than by days/weeks/months. The comic may thus be a jab at how our lives already are real time MMORPG.

In this game, especially, one would expect such shortcuts, given the extreme time frames required for geological

events to be manifested. The joke is that this game is so realistic that it's played in real time, which means for every second or hour or eon something would take in real life, in the game it would take the same second or hour or eon to happen. Playing such a game where the events take longer than the person would be alive would likely be unsatisfying.[citation needed] A mildly less extreme example of a simulation game being played in real-time is the Desert Bus video game where you have to drive a bus from Tucson, Arizona, to Las Vegas, Nevada, in real time at a maximum speed of 45 MPH. The trip requires eight hours of continuous play to complete, at which point you score one point, with the option to continue playing for additional points at the rate of one point per successful eight hour trip. The action consists almost entirely of just keeping the bus from veering off the road. It cannot be paused or sped up, and failure requires a tow back to the starting point at the same 45 MPH speed.

The frames show some elements of gameplay. The first frame shows a destructive plate margin in which an oceanic plate (grey) is being subducted under a continental plate (brown with a person standing on it) while sediments between the plates are compressed to form mountains. Clockwise from top left, the second frame shows a cross section through the planet and various statistics about the planet (CO₂ levels of 840 ppm, solar irradiation of 1184 W/m² and heat-flow through the crust of 91 mW/m²). Solar irradiation and heat-flow are similar to the Earth, but CO₂ levels are

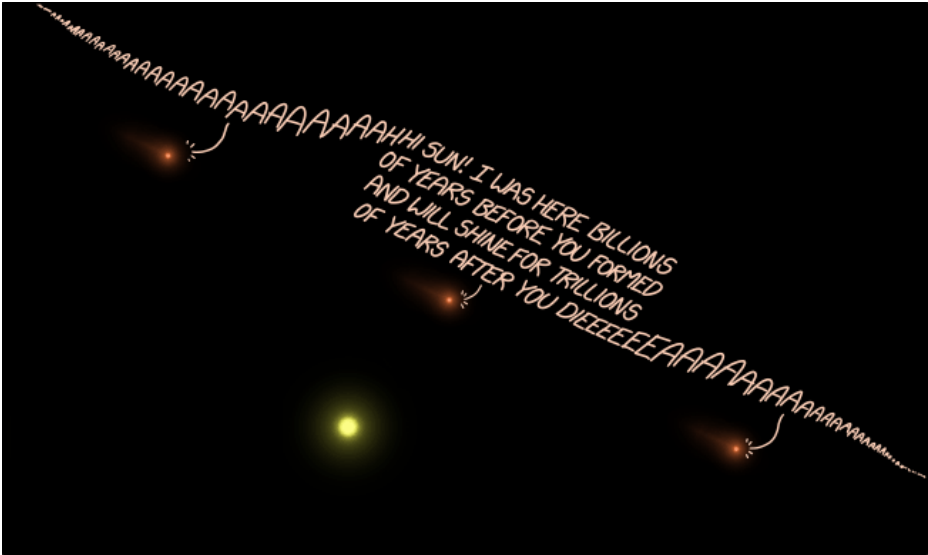
raised. The bottom right displays several stats titled LT, LM, LA and LL, and bottom left is a view of the planet showing the proportion covered by ice (3%), land (31%) and water (66%). It seems that the raised CO₂ levels have reduced the amount of ice compared to our present-day Earth. The final panel shows some of the achievements that can be unlocked; the first row shows mountains from 1 km up to 10 km, and the next row appears to show achievements in the formation of an atoll.

Large igneous provinces are extremely large accumulations of igneous rocks that have arisen when magma traveled through the crust towards the surface. They are thought to be related to widespread extinction events and rapid climate changes. Thus, they are 'the worst' in this game.

The title text mentions type A3 V stars, which are white main-sequence stars with a mass from 1.4 to 2.1 times the mass of the Sun. They have a shorter lifespan than the Sun, hundreds of millions of years compared to the 10 billion year lifespan of the Sun. By starting the game now with an A3 V star, there would be plenty of time to complete the game before the real Sun becomes a red giant star in 4-7 billion years, destroying the Earth. It's not clear how having a shorter-lived star would speed up plate tectonics on a planet of the star.

#2062: Barnard's Star

October 22, 2018



SOMETIMES I WONDER WHAT BARNARD'S STAR IS SAYING TO THE SUN AS IT PERFORMS ITS 20,000-YEAR-LONG HIGH-SPEED FLYBY.

"Ok, team. We have a little under 10,000 years before closest approach to figure out how to destroy Barnard's Star." "Why, does it pose a threat to the Solar System?" "No. It's just an asshole."

Explanation

Barnard's Star is a very-low-mass red dwarf about 6 light-years away from Earth in the constellation of Ophiuchus. It is the fourth-nearest known individual star to the Sun after the three components of the Alpha Centauri system; it is the closest star to Earth in the Northern Hemisphere. It is a red dwarf with a mass of 0.144 Solar masses, a diameter one fifth that of the Sun, and it is 7–12 billion years old. Because of this low mass the gravitational pressure in the core is much lower and thus the fusion rate is far smaller than in the core of the Sun. In fact this star is so dim that, even though it's one of the nearest, it can't be seen by the naked eye. The low fusion rate also means that the lifespan of small stars is much longer. While huge stars might last a few hundred million years, and the Sun about 10 billion years, a small red dwarf has a lifespan of about a trillion years.

Barnard's Star is the star with the greatest proper motion in the sky. Proper motion is motion in the sky other than that caused by Earth's rotation or orbit. Barnard's star is both very close to the sun (as these things go) and moving now at a speed of more than 140 km/s toward the Sun. It will make its closest approach to the Sun in approximately 10,000 years, at a distance of about 3.75 light-years.

The image on the right shows different stars near the Sun over 100,000 years and it can be seen that none of them are getting closer than 3 light-years. This is a safe distance

to our Solar System and the stars will not measurably influence the orbits of the planets or smaller bodies. It's also obvious that much closer approaches never have happened since the Solar System formed 4.5 billion years ago because otherwise the nearly circular orbits of the planets in the same plane wouldn't be possible. Closer encounters have happened in the past by mostly small stars like Scholz's Star which actually passed through the Oort cloud at a distance of 0.82 light-years about 70,000 years ago, and at least one estimate suggests that a star is expected to pass through the Oort Cloud every 100,000 years or so. This distance is still too far away to measurably influence the orbits of the planets, but those encounters cause comets perturbed from the Oort cloud to enter the inner Solar System roughly 2 million years later. (Given Neptune's mass of 5.149×10^{-5} solar masses vs. Scholz's Star's mass of 0.15 solar masses, and Neptune's orbital radius of 30.1 AU vs. the star's closest-approach distance of about 52,000 AU, the star's gravitational influence on the inner solar system was only 9.8×10^{-4} times that of Neptune.)

The comic shows the sizes and the distances not in a proper scale. If the Sun was 1.4 cm (1.4 Mio km in real) in diameter, Barnard's Star would be less than 3 mm at a distance of 356 km. Even Jupiter wouldn't fit into this picture -- at ten times smaller than the Sun, it would be a few pixels, but at a distance of 7.8 m to the Sun and all the other planets would fit into a circle less than 100 meters in diameter. The distances to others stars are far beyond human imagination and at its closest distance a

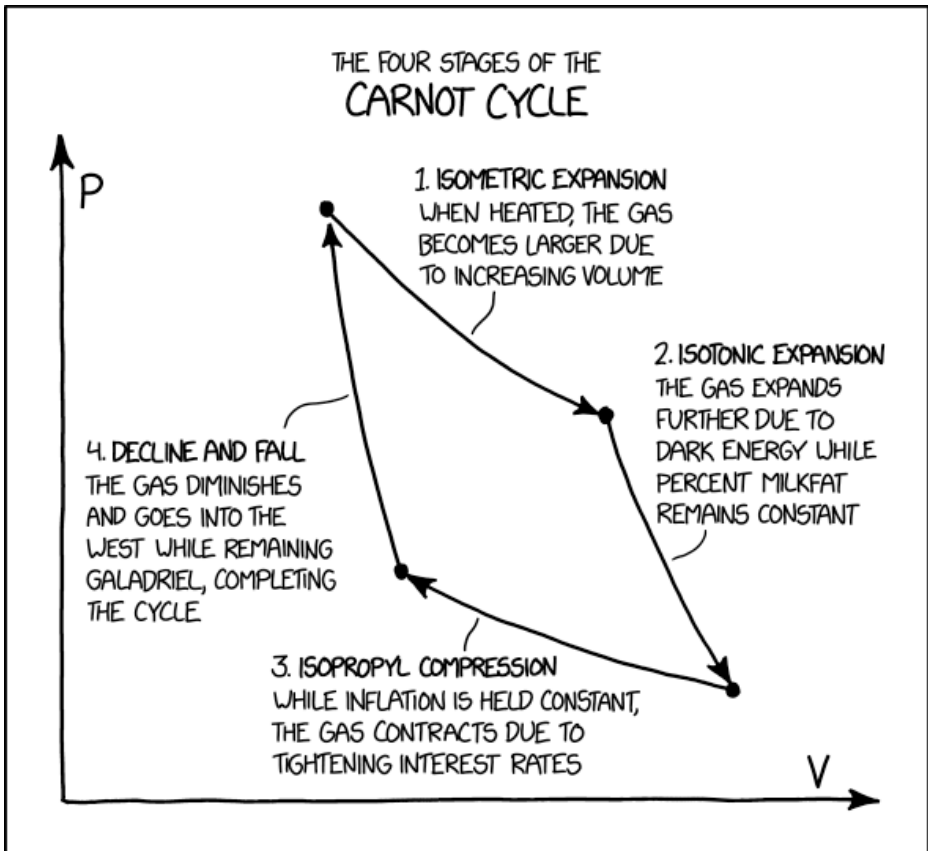
message still takes 3.75 years from Barnard's Star to the Sun.

In regards to "20,000-year-long high-speed flyby", the joke here is suggesting Barnard's Star would need to scream out the maleficent, trolling statement as quickly as possible due to 20,000 years being such a small segment of time relative to the lifespan of the star (and our Sun, for that matter).

The title text emphasizes that this close approach will not be any hazard to the Solar System, but someone is envious of the long lifetime of Barnard's Star or annoyed by its unpleasant behavior (yelling at the sun for 20,000 years would be a minuscule amount of time for the stars, but for humans it would be a vast length of time, and would get annoying very quickly).

#2063: Carnot Cycle

October 24, 2018



The Carnot cycle is more properly known by its full title, the "Carnot-Tolkien-Wagner Ring Cycle."

Explanation

This comic shows a Pressure–volume diagram which is used in this case for a Carnot cycle, a theoretical thermodynamic cycle covered in most thermodynamics classes which looks a lot like the figure drawn. The most common example of a (suboptimal) Carnot cycle is the vapor compression cycle used in refrigerators. However in this case, Randall has replaced the labels of the 4 stages of the real Carnot cycle with new ones.

Pressure–volume diagrams were first developed to understand the efficiency of steam engines and plot the change of pressure p with respect to volume V for a specific process. The process forms a cycle and the amount of energy involved can be estimated by the area under the curve on the chart. The Carnot cycle describes the ideal efficiency that such an engine can achieve during the conversion of heat into work, or vice versa like in a refrigeration system. The real steps are called (explained in short):

An isothermal process is a change of a system, in which the temperature remains constant. In this diagram the volume increases (expansion) or decreases (compression). The term isentropic describes a lossless process where no heat leaves the gas, here the increased volume only causes a further decrease in pressure; it is also called an adiabatic process and is the thing which warms air when you compress it quickly. Isentropic means "doesn't cause the heat death of the universe", which is a rare thing.

The prefix iso- is derived from the Ancient Greek word *ísos* which translates to equal and used widely in modern days in science like here to indicate a process at the same temperature (-thermal) which is not shown in the graph. The prefix is- to the term entropy is used because isoentropic sounds stupid.

In the comic, the cycle also has two phases of expansion followed by two phases of contraction (or "decline"), but the names of steps one to three are replaced with other words beginning with the prefix "iso-" meaning same or equal, and the factors that are held constant are absurd.

Each step in this comic is explained below:

1. Isometric expansion. When heated, the gas becomes larger due to increasing volume

Isometric (literally "equal dimensions") can refer to a property or process that is symmetrical in all dimensions (i.e. the gas is expanding radially) or to a type of thermodynamic process where volume is held constant but temperature is free to vary, the exact opposite of the first step in the real Carnot cycle. Additionally, the comic text uses a circular argument (become larger due to increasing volume).

In mathematics, an isometric mapping (between metric spaces) is a map that keeps all the distances intact. If we measure the distance the same way throughout the cycle, then isometric expansion (or for that matter, isometric compression) is not really an expansion (or a

compression).

2. Isotonic expansion. The gas expands further due to dark energy while percent milkfat remains constant.

Isotonic is a descriptor commonly associated with sports drinks (and not thermodynamics), which contain similar concentrations of salt and sugar as in the human body. Dark energy is hypothesized to be a cause for the accelerating expansion of the universe, which obviously isn't relevant to thermodynamics (yet). The density of milk depends on milkfat and solids-non-fat, which includes lactose. Fortified milk has increased solids-non-fat but the same percentage of milkfat, resulting in increased calories and an increased density. So the fortification of milk results in increased calories, possibly referred to as dark energy, and a contraction, as less space is needed for 1 kg of milk. However, this explanation does not match the expansion suggested in the comic.

Later Randall again combined dark energy (and also dark matter) with milkfat in 2216: Percent Milkfat.

3. Isopropyl compression. While inflation is held constant, the gas contracts due to tightening interest rates.

Isopropyl alcohol is commonly used for cleaning. Inflation and contraction could refer to changes in gas volume, but the reference to interest rates puts them in the context of macroeconomics. Raising ("tightening")

interest rates tends to reduce inflation and/or "contract" the economy. High interest rates are a feature of the third stage (recession) of the Juglar cycle. In economics (and other sciences) to better understand model parameter relations, some parameter may be held constant in theory. This could refer to the Fisher equation. Holding one parameter constant is also done in the Carnot cycle (for a physical parameter): not only in theory but also in practice! (In free market economies the inflation cannot be directly held constant).

But inflation may also refer to dark energy mentioned at the isotonic expansion section above. Inflation in cosmology is a theory of the exponential expansion of space in the early universe, an effect associated with the "accelerating universe" and for which findings the 2011 Nobel Prize in Physics was given. The National Geographic blog entry Nobel Prize in Physics 2011 – The Accelerating Universe explains that "...Today, most physicists, influenced by inflation, would ... call it dark energy."

4. Decline and fall. The gas diminishes and goes into the West while remaining Galadriel, completing the cycle.

Galadriel is a character in The Lord of the Rings. She is one of the leading elves, a race that in the time of the book is said to be dwindling (in number and importance) in Middle Earth and migrating westward to Valinor. Galadriel is one of the last elves to leave, after successfully resisting temptation to take the One Ring and become an all-powerful queen who dominates Middle-earth, instead

saying "I will diminish, and go into the West, and remain Galadriel." The title may be a reference to Edward Gibbon's 18th century masterpiece *The History of the Decline and Fall of the Roman Empire*, or to the novel *Decline and Fall* by Evelyn Waugh (which is itself a reference to Gibbon's book). This stage is present in the cycle because in the real cycle, at this stage, volume of the gas decreases without exchange of heat. It is the last stage after which the gas has its original value of variables, thus completing the cycle.

The title text refers to Richard Wagner and J.R.R. Tolkien. Wagner's Ring Cycle consists of four operas. Tolkien wrote *The Lord of the Rings*, which some have suggested was inspired by Wagner's Ring. Their works are known as literary cycles.

#2064: I'm a Car

October 26, 2018



I'm the proud parent of an honor student, and the person driving me is proud, too!

Explanation

This comic was released eleven days before the United States midterm elections on Tuesday, November 6, 2018 and even the header text at the top of the xkcd page had changed a few days before by showing a link to [vote.org](https://www.vote.org) to help US citizens to register and finding their polling places.

This comic shows a car with a bumper sticker. Bumpers stickers display a short message the owner of the car want to show to other drivers or pedestrians. They are usually used to express a viewpoint, whether personal or political, held by the owner or driver of the car. This comic makes literal the ones that include or allude to the personal pronoun "I" and its variations, i.e. first person singular statements. Of course the intent is that "I" is referring to the person who put the bumper sticker on the car, but as the sticker is attached to the car the more literal interpretation is that "I" is referring to the car. So the humor is derived by the notion that the car itself is making these statements. (On an even more meta level, the comic could be interpreted as saying that the person who wrote the words in the comic, i.e. Randall, is saying that he is a car.)

The bumper sticker on the car in the comic is a variation of a sticker used to both encourage people to vote, as well as express their political position: "I'm a ____, and I vote" (where the blank is traditionally filled in with "Union Worker", "Catholic", "Senior Citizen", "Gun Owner" or

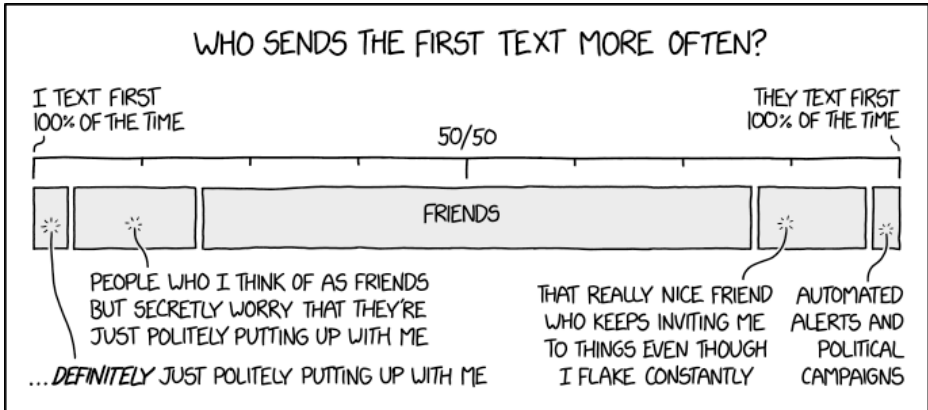
some other demographic or organizational membership). However here it is attributed to an automobile which is not capable of voting.

The comic could be an indirect reference to the growing "intelligence" of self-driving cars, such that one day they might have the intellect to communicate, vote, and engage in other self-motivated activities. See 'Sally' by Isaac Asimov. It may also relate to security concerns around increasing use of electronic voting mechanisms - the joke being that the car is able to abuse the interfaces to such systems either to vote on behalf of its owner or as its own entity. Though voting might not be one's biggest concern if their "intelligent" car got dragged into a bot net...

The title text seems to be another typical message on a bumper sticker, saying that the driver is a "Proud Parent Of An Honor Student". However, this sticker is a bit longer, since it continues to state that "the person driving me is proud, too". Thus once again it is the car who is the proud parent. And thus maybe it is a car that is the honor student? Another thought is that this may be a reference to the 1965-66 TV sitcom *My Mother The Car*.

#2065: Who Sends the First Text?

October 29, 2018



I sort of wish my texting app showed the percentage next to each person, but also sort of don't want to know.

Explanation

Text messaging is a back-and-forth communication via SMS between two users. In this comic, Randall shows a line graph of "who sends the first text more often?" This is meant to show who Randall initiates conversations with, and who initiates conversations with him.

Maintaining a friendship or relationship (whether intimate, friendship, casual, or business) typically requires communication; often that communication takes place when two individuals are not in the same location by means of an exchange of text messages. A normal balanced relationship typically involves both parties involved to have an approximately equal interest in making conversations happen, as measured in this case by "who sends the first text". The person who desires that a particular communication take place typically will send a text message, and once the other person responds the conversation happens, and the relationship progresses. If neither person initiates, the relationship will likely suffer.

While the majority of this graph shows relationships which involve friends whereby both sides are prone to initiating conversations, the graph also shows some groups that are a little more at the extremes, some where Randall texts a lot but they typically don't initiate text conversations to him, and some where others text him a lot but he rarely initiates text conversations with them.

On the left side of the graph are people with whom Randall initiates conversations with "100% of the time". On the right side of the graph are those who initiate conversations with Randall.

The chart is separated into 5 blocks. The two blocks on the left are those who may be, or definitely are, "just politely putting up with [Randall]". This is implied that they may not be close friends with Randall, but Randall still wants to be friends with them. Their reluctance to initiate conversation with Randall is shown by the fact that Randall usually sends the first text to them.

The largest block, in the middle, is "friends". These friends range from Randall initiating a lot, to them initiating a lot. There is a healthy range of who initiates first.

The next block to the right is for "that really nice friend who keeps inviting me to things even though I flake constantly". This means that Randall promises to go to events that this friend invites him to, but does not always follow through. This friend is still persistent in inviting Randall. Additionally, Randall could be less close to this person, based on him not categorizing this person under "friends".

The final block is "automated alerts and political campaigns". Randall would certainly not be likely to initiate "conversation" with automated systems, and would be very unlikely to initiate conversations with political campaigns. The fact that the bar is not purely

100% suggests that he has on rare occasion sent the first text to such recipients, perhaps for a campaign he believes in, or to request to be added to an automated alert system (i.e. opt-in). The fact that it includes political campaigns is a reference to the incessant texts being sent to Americans about the upcoming midterms.

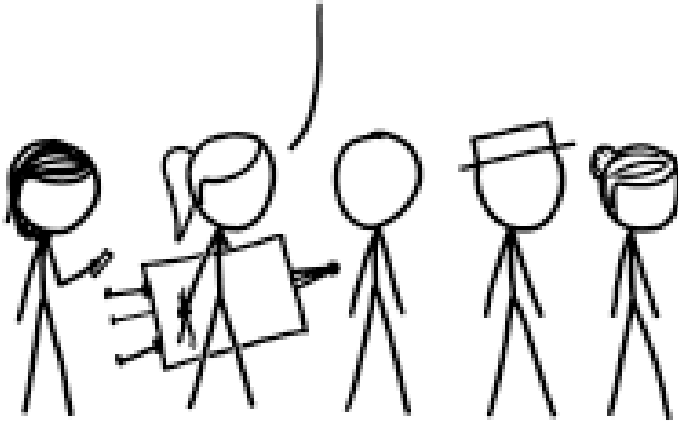
In the title text, Randall wishes that he would know the percentage of "who sends the first text more often", for each person that he texts. But he is also wary of the potential implications of finding out this information.

(Many old school messenger like pidgin offer such statistics through plugins though)

#2066: Ballot Selfies

October 31, 2018

BALLOT SELFIES ARE ILLEGAL IN THIS STATE, SO TO IMMORTALIZE MY VOTE I'M DOING AN OIL PAINTING IN THE VOTING BOOTH.



There were actually some good reasons for those laws, but IMO they now do more harm than good. Which raises a question: If there's a ballot measure to strike them down, how can I resist the urge to take a picture of my "yes" vote?

Explanation

This comic was published six days prior to the 2018 United States general elections, also called midterm elections, because they happen halfway between two presidential elections, two years before and after. At the time, the xkcd header still provided a link to [vote.org](https://www.vote.org), a website that helps US citizens with essential voting issues, like how to register or how to find their polling locations. It is the first of three consecutive comics that deal with this election.

In the United States, "ballot selfies" refers to the practice of taking a picture of oneself with a completed ballot. These have been illegal in many states, due to laws passed to prevent vote selling.

Without proof of how a vote was cast, if someone bribed (or even violently coerced) a voter to vote for candidate A, the voter could just vote 'B' and the coercer would be unable to tell whether they voted as instructed. This is at the heart of the concept of "a secret ballot". But if ballot-selfies or other proof-of-vote mechanisms are permitted then the evil-doer can demand verification that the voter did what they were coerced to do — and this jeopardizes the idea of a truly free and fair election.

However, the "secret ballot" principle is not universally valued nor enforced. Some voting machines produce a paper receipt showing the choices the voter made — and many jurisdictions permit use of a postal ballot — so

there are plenty of other ways to circumvent the law in those places. So the ban on ballot selfies is harder to justify unless those other lines of coercion are also ruled out.

On the other hand, the desire to take and distribute ballot selfies often comes from an excitement in participating in the voting process and the desire to share that excitement in the hopes of encouraging others to vote, and anything that helps get more people to the polls is generally considered to be a good thing. In addition, the law is incredibly difficult to enforce — there is little way to prevent somebody from photographing their ballot and privately showing this photo to somebody else — and the practice of enforcing it (i.e. searching for possible photographic devices all together) would make the local government incredibly unpopular. Lastly, voters storing evidence of their votes could be useful to prevent voting fraud performed by the state.

This dual threat/benefit has led some states to explicitly legalize ballot selfies, other states to specifically disallow them and even levy steep financial penalties, while the rest are still debating or ignoring the issue.

As Ponytail is aware of this law, she believes she has identified a solution wherein she will make an oil painting of her voting rather than taking a photograph. A painting being more of an artistic endeavor that doesn't have to faithfully record all aspects of the image, it may well be valid both on grounds of freedom of speech as well as not being a verbatim record of her vote -

thereby preserving the secrecy of the ballot. Of course, making a painting of her vote may lead to additional problems. If she intends to paint the portrait herself, of herself (i.e. a self-portrait) casting her vote, it would be very difficult and time consuming to attempt to do that, especially without a mirror, which she apparently doesn't have with her and which is generally not standard issue in voting booths.[citation needed] She could also try to recruit someone else to do the painting, not knowing the level of their artistic talent, however, usually only the person casting the vote is allowed in the booth, and they are expected to close the curtain or otherwise ensure no outside person, like the painter, can view the vote casting act. It would also require her to stay in the booth longer than most voters.

While Hairbun and White Hat are simply standing in line, Megan can be seen using a mobile phone.

The comic might also be a reference to the existing ban of cameras in US courtrooms, which led US newspapers to widely adopt cartoons as a replacement.

In many US states, changes to state law can be made through the initiative and referendum process, which can be initiated and pursued by any citizen.

The title text refers to the legality of taking a ballot selfie whilst voting against the law against ballot selfies.

#2067: Challengers

November 02, 2018



[LOADING...]

Use your mouse or fingers to pan + zoom. To edit the map, submit your ballot on November 6th.

Explanation

Regarding the midterm elections held in the United States on November 6, 2018, this comic shows probably all challengers, which are candidates running against the current officeholder, as well as those running in open seats where a change of the major party from the previous election could occur. It is the second of three consecutive comics that deal with this election.

Randall states on top that "The bigger the candidate's name is,"

- the higher the office is in command structure, and
- the better their chances of success as a challenger are

While an office can be subclassified by order from state down to county, the guesses on better chances to success can be only based on surveys before the elections.

All names provide an indirect link to the first Google Search result on that specific person and position. As common, Democratic candidates are shown in blue text, Republican candidates in red, and independent candidates are in green.

The landmarks shown in gray are essentially links to Wikipedia pages containing coordinates pointing to the US in their body (both visible on the site and hidden in the wiki source) that point to places in the US. If they contain more than one coordinate then the first one is used, for example the List of the major 3000-meter

summits of the United States page is shown in Alaska, and the xkcd page is linked near Boston, Massachusetts. This list seems to be auto generated from a Wikipedia dump made possibly before 2017. There doesn't seem to be any other criteria as the list also contains orphaned wikipedia pages that only contain hidden coordinates in their sources pointing to the US, for example this one. Wikipedia pages containing these coordinates can be easily enumerated on the site in blocks of 500 at a time.

Since the map is large there's also a loading screen present that can be seen while the map is loading. There are a total of nine comics embedded into the map at various locations. They are showed when zooming into the map at the appropriate section.

The title text shows the hint that the reader can zoom in and move over all fifty states to reveal details which can't be easily seen in the overall view. Furthermore, while a typical opensource and interactive mapping project might provide on-site means to edit the data to render, here Randall called upon Americans to use their vote as the official method of changing how the picture ought to look.

Attack Ads[edit]

Location: Lubbock, Texas

Attack ads are campaign advertising that usually attack the opponents' campaign instead of promoting one's own. The comic also refers to the fact that media outlets usually spike their advertising prices during the campaign, and it becomes cheaper

afterwards. However, there's usually no point in advertising afterwards for a campaign as the polling has already taken place. This may also be a callback to 1130: Poll Watching.

Lubbock was the place where some attack ads were shown few months before the election. Texas is also notable as in 2008 during the Democratic Party primary Hillary Clinton started running attack ads aimed at Barack Obama, who later became President, causing controversy.

Ballot Measures[edit]

Location: Weed, California

Ballot measures are proposed laws that are approved and rejected by voters. In California, apart from the elections to Congressional and state offices, there will also be 12 extra propositions for the voters in this election. Sometimes propositions also include changing how voting should be done in subsequent elections. There are people who believe proposals on US ballots are asked in a very convoluted way and could be made simpler.

In this comic a lot of the proposals sound complex and self-referential as well, therefore Megan just says that she doesn't wish to vote to any of them and would actually like to ban people creating ballot papers like this. Not voting might also refer to the scenario where people believe none of the choices during an election are good, and instead vote to no-one or deface their ballot papers in protest.

The name of the town chosen, Weed, California, may be a pun on how marijuana is legal in California. However, Weed is a real town in Northern California.

Carlymandering[edit]

Location: Bellingham, Washington

This refers to gerrymandering, a tactic used to re-shape voting district boundaries to make sure one candidate prevails over the other. "Carlymandering" is a malapropism which combines gerrymandering with Carly Rae Jepsen, a Canadian singer, whose single "Party for One" was released the day before the comic's publication. Although the song is about partying (e.g., going out) alone, the joke is that it could also mean a one-person political party, and she would have a full gerrymandered district to herself.

Jepsen lives in Vancouver, which is just on the other side of the US border in Canada. The comic is placed in Whatcom County, which is notable for Point Roberts, a peninsula which, although part of Washington state, is actually an exclave of the US, as it's surrounded by sea on three sides, and has its only land border with Vancouver to the north. The comic might refer to the fact that Jepsen could solely live in this exclave. However, since she is not a US citizen, she can neither vote nor be elected in US elections.

House[edit]

Location: Washington, DC

Comic is probably referencing the White House, the residence of the President, located in Washington, DC. This could also refer to the Capitol Building, the home of the House of Representatives, also located in Washington, DC.

Polls[edit]

Location: Primm, Nevada

The word "poll" has two distinct meanings in regard to elections -- the place where you go to cast your official vote is called a poll, as are the unofficial surveys done to try to gauge how people are likely to vote.

During campaign there is usually polling done by survey companies to determine each candidate's chances of winning. This comic refers to the fact that often the candidate that is behind in the unofficial polls tells their electorate that these polls don't matter, as they are just surveys and not the actual final result. This is usually to encourage their voter base that it's still worth voting for them. The joke here is that Blondie doesn't finish here but tells the electorate that other polls are actually also important.

Nevada is one of the states where there is only a slim difference between the candidates based on polls hence the need for each candidate to rally their supporters and make sure everyone is voting.

Punish[edit]

Location: Chadron, Nebraska

Often candidates make promises of things they will do when they are elected. Vowing to find and punishing people responsible for a certain action, oftentimes criminals, is also common. However, certain performance artists aside, these two things are generally not conflated, as they are here, to ludicrous effect.

Putting this comic into Nebraska might refer to the fact that in

2016 Nebraska voted to repeal the death penalty ban, allowing the reinstatement of the death penalty, also called capital punishment, in the state.

Scholten[edit]

Location: Storm Lake, Iowa

J.D. Scholten is a Democratic candidate for Iowa's 4th Congressional District. Steve King is a Republican representative who has stirred controversy due his endorsement of candidates, in other countries, who were members of parties with white supremacist ties, and he has explicitly and frequently stated concern with the American society being destroyed by "other people's babies".

King would go on to win re-election by a narrow margin and continue to court controversy, only to fall in the Republican primary two years later in June 2020.

Spanberger[edit]

Location: Richmond, Virginia

Abigail Spanberger was a candidate running for Congress in Virginia's 7th district, which includes Richmond. Based on polls she had a chance to beat her opponent, and she then became the first Democrat in her district after 50 years of Republican control, beating out Republican incumbent David Brat by 2 percentage points. Cueball probably was trying to encourage people to vote for her on election day.

St Louis[edit]

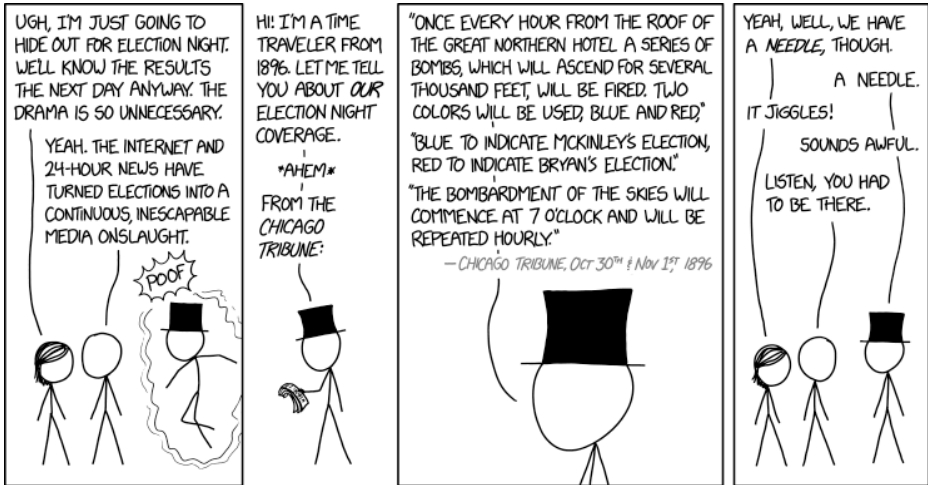
Location: Saint Louis, Missouri

Saint Louis, Missouri is the location of the Gateway Arch, the largest arch in the United States. (It's also one of the most recognizable arches in Saint Louis, according to 1368: One Of The.) Since in this comic they are next to the side of the arch, it is possible its sheer size stops them from determining what it is, although they should probably know. An alternate interpretation is that they are baffled by the existence of a giant, seemingly-useless steel arch, and do not know what to refer to it as.

The area surrounding the Arch was known as Jefferson National Expansion Memorial until February 2018, when it was renamed to Gateway Arch National Park.

#2068: Election Night

November 05, 2018



"Even the blind—those who are anxious to hear, but are not able to see—will be taken care of. Immense megaphones have been constructed and will be in use at The Tribune office and in the Coliseum. The one at the Coliseum will be operated by a gentleman who draws \$60 a week from Barnum & Bailey's circus for the use of his voice."

Explanation

This is the third comic in a row that deals with elections in the United States; the trio has been published in the week before the US midterm elections held on November 6, 2018 and it compares media coverage on election results in 1896 and 2018. During this time the Header text of xkcd was also changed three times, including on the release days of both this and the previous comic, to help people go and vote. See more in the trivia section.

While elections and voting have been a public staple for generations, election coverage by the media can result in voter fatigue. While voter fatigue is considered a major criticism of things like first past the post voting systems, media outlets will also contribute.

The time traveler from 1896, wearing a top hat (the typical hat used at that time), presents Megan and Cueball a method how the latest news --over the night-- is published to the public. No broadcasting television or even radio existed then and most newspapers, reaching the readers on the next morning, were printed in the evening before the election results were certain. For the election referenced in this clipping, Republican candidate William McKinley (assigned the color Blue) won in a close race against Democrat-Populist candidate William J. Bryan (assigned the color Red).

Here, Randall is taking a unique opportunity to point

out that unlike our recollection of history (which is usually modified by the misinformation effect, where we perceive the past as being easier and find a source to blame for the election night jitters) that in fact, in the past, a bombardment of fireworks every hour was used to convey the hour-by-hour play of the election night, a significantly more jarring effect that couldn't even be turned off. We have progressed, in some ways, to a more opt-in system, rather than the opt-out system of the past, where you had to leave Chicago to avoid the news.

The part about the "jiggling needle" is likely a reference to the New York Times' 2016 presidential election results webpage. It displayed a "needle" representing a live election night forecast of the results of the presidential election between then-candidates Donald Trump and Hillary Clinton, jiggling to reflect uncertainty. The position of the needle was initially set based on pre-election polls, pointing heavily toward Hillary Clinton, but as election results from around the country -- and from individual counties within states -- started coming in it changed to reflect those results. In the 2018 midterm elections, the needle was once again used.

The title text explains that in 1896 even blind people were taken care of, as enormous megaphones were installed to convey the news equally unavoidably to those who couldn't (or didn't want to) see the color bombs. This is in fact true but was intended for those in the Coliseum, not all of Chicago.

#2069: Wishlist

November 07, 2018

- MARIO/LUIGI HYBRID
- THE SKIFREE MONSTER
- SIRI
- ELLIE FROM UP
- ZORDON
- CLIPPY
- THE SARLAAC
- THE INSTALLSHIELD WIZARD
- MR. CLEAN
- COMET CURSOR
- BETO O'ROURKE
- THE MONOPOLY BOOT
- LOT'S WIFE
- D.B. COOPER
- THE BLAIR WITCH
- MAVIS BEACON

SUPER SMASH BROTHERS
NEVER DID END UP ADDING
ANYONE FROM MY WISHLIST.

Disappointed that they caved to fan pressure and went with Ruth Bader Ginsburg over Elena Kagan.

Explanation

Super Smash Bros. (pronounced Super Smash Brothers and usually shortened to Smash) is a crossover fighting game series published by Nintendo, with the core roster of playable characters originating from Nintendo's own franchises such as Super Mario and The Legend of Zelda. At the time this comic was published, there were 77 playable characters in total across the 5 games in the series. Starting with the third game, Super Smash Bros. Brawl, characters from third-party franchises (non-Nintendo) have been made available, though most of them had at least made major appearances on a Nintendo system at some point. This comic is a parody of various fans' wishes for the roster of Super Smash Bros. Ultimate, which was announced in 2018 along with multiple trailers revealing new characters to appear in the roster. In the November 1st trailer it was stated every new character in the launch version of the game had been announced, though with five more characters coming in 2019 as downloadable content (DLC).

Throughout the series fans have suggested new characters to add; however, developer acquiescence to these requests is rare, with only six characters out of 77 (King Dedede, Steve, Sonic the Hedgehog, Ryu, Bayonetta, and Ridley) having been added this way. On November 3rd, 2018, the developer studio Sora Ltd. made a statement on Twitter telling fans that the as-yet unrevealed DLC characters for Ultimate were already chosen and that they were not accepting further requests;

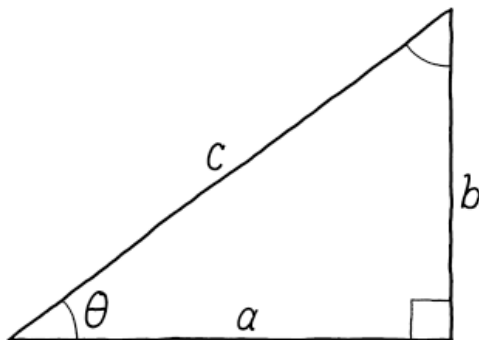
all remaining characters would then be gradually released over the next three years, culminating in Sora's reveal in October 2021.

This comic lists 16 "characters" that Randall supposedly wishes were made available in Super Smash Bros., ranging from plausible playable characters, to the absurd.

The title text refers to two US Supreme Court Associate Justices who were considered as additions to Smash. Ruth Bader Ginsburg was appointed by Bill Clinton; Elena Kagan was appointed by Barack Obama. Both are considered to be on the "liberal" wing of the court, but Ginsburg's forceful dissenting opinions may explain why she would have been a more popular character for Super Smash Bros. Additionally, Ginsburg has been parodied on Saturday Night Live, adding to her popularity:

#2070: Trig Identities

November 09, 2018



$$\sin \theta = \frac{b}{c} \quad \cos \theta = \frac{a}{c} \quad \tan \theta = \frac{b}{a}$$

$$\cot \theta = \frac{a}{b} \quad \sec \theta = \frac{c}{a} \quad \csc \theta = \frac{c}{b}$$

$$\csc \theta = \frac{b}{a} \quad \sec \theta = \frac{c}{a} \quad \tan \theta = \frac{b}{a}$$

$$\cot \theta = \frac{a}{b} \rightarrow \cot \theta = \frac{a}{b} \rightarrow \cot \theta = \frac{a}{b}$$

$$\tan \theta = \frac{b}{a} = \frac{b}{a} \cdot \frac{c}{c} = \frac{b}{c} \cdot \frac{c}{a} = \sin \theta \sec \theta = \text{insect} \theta^2$$

$$(\tan \theta)^2 = \frac{b^2}{a^2} \rightarrow t^2 n^2 a^4 = \frac{b^2}{\theta^2} \rightarrow at^2 ba(na)^2 = \frac{b^3}{\theta^2}$$

FROM PHYSICS
distance = $\frac{1}{2} at^2 \rightarrow \text{distance 2 banana} = \frac{b^3}{\theta^2}$

KEY TRIGONOMETRIC IDENTITIES

ARCTANGENT THETA = ENCHANT AT TARGET

Explanation

This comic shows several real trigonometric identities at the first two lines and further below some identities "derived" by applying algebraic methods to the letters in the trigonometric function names, which is obviously nonsense.

The first line are the known trigonometric functions: sine, cosine and tangent, and the second line contains the reciprocals of the trigonometric functions from the first line: cosecant, secant, and cotangent.

The following identities are made up and are increasing in absurdity. The comic reflects on the confusion one gets when working more intensely with these identities, since there are a lot of hidden dependencies between them. You can also check how they are related through the various Trigonometry Formulas.

The third and fourth line is made by treating the trigonometric function as a product of variables rather than a function and then using the above identities to create words. e.g. $\sin = b/c \rightarrow \text{cin} = b/s$ (this could also be a reference to the C++ `cin`).

The second to last line performs some algebra on the individual letters of $(\tan \theta)^2 = b^2/a^2$ as a setup to the last line. The last line takes the formula $\text{distance} = 1/2 at^2$ "from physics" and plugs it into the equation of the previous line, doing some algebra to replace at^2 with

distance2 and expanding $(na)^2$ into nana to get the final equation, distance2banana = b^3/θ^2 . This is valid algebra only if the trigonometric operators are taken as variable products rather than operators, but this is a common misconception encountered when people first learn trigonometry. The distance equation is the distance a constantly accelerating object initially at rest moves in a given length of time t, most often used to find how far an object dropped from rest will fall under the influence of gravity in a given amount of time (or how long it will take to fall a given distance).

There are a few formulas that have mistakes if you simply make algebraic manipulations to the six standard trigonometric functions.

- $\text{cas } \theta = o/c$ seems to be derived from $\cos \theta = a/c$ but to reach "cas" from "cos" one has to divide by "o" and multiply by "a". This would lead to $\text{cas } \theta = a^2/oc$.
- In the identity $\sin \theta \sec \theta = \text{insect } \theta^2$ one of the "s"'s has turned into a "t", however this may be reached by 'phonetic stretch' from the sound of saying 'sin sec' together being similar to the sound of the word "insect". Another possible conversion is if you treat "s" as seconds, then "t" could be time, which keeps with the identity theme.

The title text is an anagram. Due to the commutative property of multiplication (which states that order does not affect the product), these equations are equivalent if treated as individual variables as earlier. Another layer of absurdity is added in that the variable Theta is spelled out

and broken into its letters, which are then treated as individual variables. (The arctangent referred to here is the inverse tangent, a one-sided inverse to the tangent function. You would not normally write θ , since the theta in the comic refers to an angle, and the arctangent has an angle as its value rather than as its argument; however, using theta here is merely unconventional, not forbidden.) The arctangent generally produces theta, the meaning of it being taken on theta being poorly understood. Randall here elucidates, via tongue-in-cheek algebraic proof, that taking a second arctangent of theta produces magical effects.

From physics (and beyond)[edit]

The formula $s = \frac{1}{2} at^2$ gives the distance a uniform accelerating object reaches over time. The second formula belongs to astronomy and the third law of Kepler in which the square of the orbital period of a planet is directly proportional to the cube of the semi-major axis of its orbit, meaning the fraction of b^3 and t^2 is a constant (banana).

But using the angle θ as an argument leads to Richard Feynman, who did many famous Lectures on Physics and his lost lecture about the Motion of Planets Around the Sun from 1964 in which he only used geometry, based on the orbital ellipse, a circle around, and matching right-angled triangles to illustrate this law from Kepler. For deeper understanding why it really does work there is a nice presentation at the "Journal of Symbolic Geometry": Feynman Says: "Newton implies Kepler, No Calculus Needed! (Brian Beckman, 2006)"

Proof of algebraic mistakes in the comic[edit]

Some have tried to argue there are mathematical justifications for the errors in some of the formulas, by stating (without proof) that you could prove that valid solutions to the original six trig identities (where letters are taken to be variables multiplied together) can be manipulated to show that solutions must have

These proofs are incorrect and can be shown easily with a counterexample. If you make the following assignments of variables like

However in this valid assignment, we have

This demonstrates that you can not make a valid algebraic derivation of

without additional assumptions beyond the six given trigonometric identities.

#2071: Indirect Detection

November 12, 2018

[illegible]

EVERYONE ON HERE NEEDS TO STOP LAUGHING ABOUT HOW "ADOPTING PETS FROM A SHELTER IS FOR LOSERS" AND "THOSE ANIMALS SHOULD ALL BE HUNTED FOR SPORT INSTEAD." IT'S REPREHENSIBLE ON SO MANY LEVELS! FIRST OF ALL...

SOMETIMES, ONE OF MY FRIENDS POSTS AN ANGRY RESPONSE TO SOME TERRIBLE OPINION I'VE NEVER HEARD BEFORE, AND IT'S A WEIRD INDIRECT WAY TO LEARN HOW AWFUL THEIR OTHER FRIENDS MUST BE.

I'm like a prisoner in Plato's Cave, seeing only the shade you throw on the wall.

Explanation

This comic shows an angry social media post by one of Randall's spiky-haired friends, objecting to the views of unknown third parties, which appear to be a cartoonishly and unrealistically evil take on the proper treatment of abandoned animals. This could perhaps be in part a callback to 2051: Bad Opinions, in which Cueball is looking to post a response to an absurd or inflammatory opinion that currently may or may not actually exist anywhere on the internet. Sometimes when posting something on social media, such as Facebook, that post can be seen by all the people you have designated as your "friends." In this case the original comment was intended to be read by the people holding these views, people who are not direct friends of Randall's and whose posts he therefore could not see, but because it was posted by his direct friend he could read that response and was able to imagine what it was those other people were saying. Knowing a little about what these other mystery people are saying, through direct quotes from within his friend's comment, and having to fill in the rest by his imagination, he reflects on how weird it is to learn that people who hold such views exist in such an indirect manner.

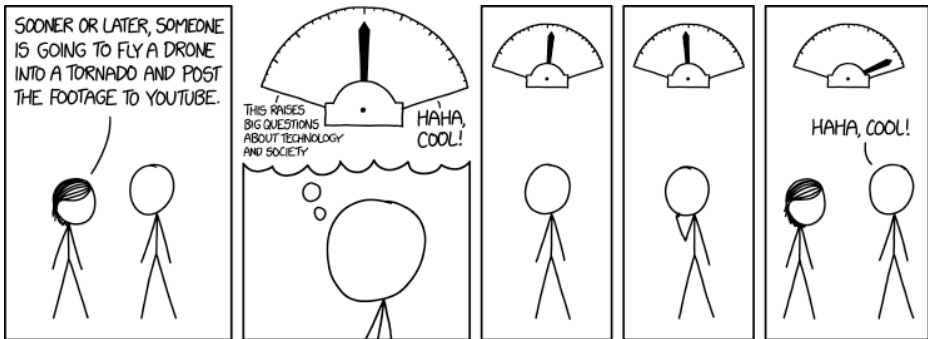
The title text is a pun comparing the shadows of Plato's cave to the practice of "throwing shade" (slang for throwing insults, usually subtly), and "the wall" could have a double meaning of both the wall of the cave and the term for someone's social media page.

The Allegory of the Cave is an allegorical concept presented in Plato's Republic. It proposes the notion of a cave in which prisoners are trapped, from childhood, in such a way that the only thing they can see is one wall of the cave, and the shadows that are cast on that wall are their only exposure to the world outside the cave. Plato proposes that these prisoners would accept these shadows as their only reality, lacking the context to understand that they're merely shadows cast by objects they can't see. In this way, Plato's Cave serves as an allegory for our limited understanding of phenomena that occur primarily or entirely outside direct perception by our natural senses.

In the same way, Randall seems to acknowledge that he doesn't actually know what goes on in the social or internet circles that he doesn't inhabit, and is left trying to figure them out, solely by the reaction of others to them.

#2072: Evaluating Tech Things

November 14, 2018



Also known as the **Black Mirror-Mythbusters** scale.

Explanation

The rapid pace of technological advancement frequent raises the possibility of doing things that were either impossible, or at least impractical, for all of human history. In many cases, these new possibilities are exciting and fun, but at least some of them present major concerns about how they'll impact society. Things like atomic fission, the Internet, CRISPR technology, are amazing things we have learned how to do, but they also have the potential, in some cases already realized, of massively affecting human life (e.g. nuclear annihilation, instant wide-scale communication, elective genetic engineering), both for the better and for the worse.

Here Cueball, upon hearing of a cool idea he hadn't thought of before, mentally measures it on a scale to decide if he can be excited about it, or should be worried about how it might affect humanity. This process is represented by an analog meter with one extreme labeled "This raises big questions about technology and society", and the other simply labeled "Haha Cool!". After weighing it out, he decides it's just plain cool and it will not adversely affect humanity at all. In the comic, it appears this mental decision took awhile, judging by the multiple panels showing him thinking, ambivalently rubbing his chin as the dial oscillates left and right, before he gives his response.

The title text refers to this mental weighing also being known as the Black Mirror–Mythbusters scale.

Black Mirror is a British anthology series, mostly falling into the genre of near-future science fiction. Most episodes with the impacts of current and/or potential technology on society, usually focused on the negative and even destructive effects that technological change can have.

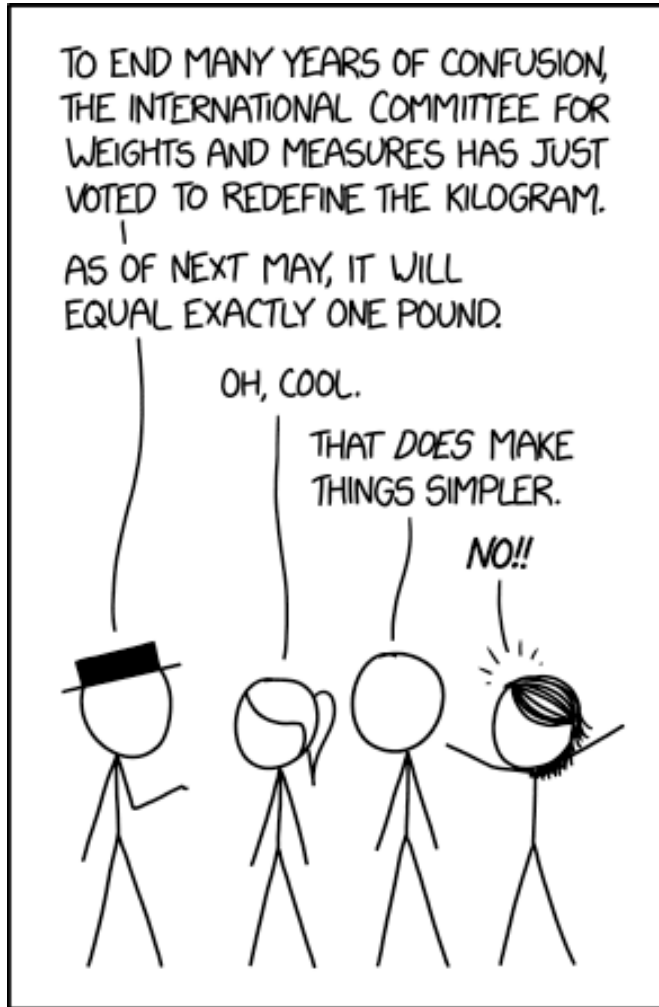
Mythbusters was a long-running science education/entertainment program in which the hosts explore myths, urban legends, and other various claims and concepts by designing and building experiments to test them. The show was famous for advancing the notion of experimentation to a broad audience, as well as for the elaborate and often exciting experiments they conducted (including a large number of dramatic explosions).

Randall appears to use Black Mirror as an emblem of the frightening and dangerous aspects of science and technology, and Mythbusters as a benchmark for having fun with science by using it to do cool things.

Worrying about the effect that technology has on our lives is a theme that has been explored before, in 1215: Insight.

#2073: Kilogram

November 16, 2018



I'm glad to hear they're finally redefining the meter to be exactly three feet.

Explanation

Standard units such as the kilogram, meter, and second are redefined from time to time as measurement technologies improve. These redefinitions are generally done to improve the precision to which the various units can be known or reproduced, without changing their actual value. The joke here is that redefining the kilogram to equal one pound sounds like an incredible idea to Americans who never use the kilogram. However, this idea would cause mass confusion and outrage, and would additionally fail to improve the precision of the kilogram.

In this comic, Black Hat announces that the kilogram has been redefined as equal to one pound. Ponytail and Cueball seem to think this makes things simpler, but Megan is alarmed. The metric system of measurement is the one used by most of the world and is the standard system used in science. Redefining the kilogram to be equal to the pound would be very disruptive and outrage supporters of the metric system. This is for two reasons. The first is that since the pound and the kilogram are completely different, redefining the kilogram to a new size from before will create a lot of confusion, since now when people read a mass in kilograms they need to work out whether it was written in old kilograms or new (pound-sized) kilograms.

The second reason is that the current definition of the pound relies on the kilogram, as the pound is officially defined as 0.45359237 kilograms. If the kilogram is

defined in terms of the pound, which is still defined in terms of the kilogram, then in effect the kilogram is defined in terms of itself. This is illogical, leads to potentially spiralling redefinitions, and does not solve the original problem of increasing the precision of the kilogram measure.

On the day of this comic, the General Conference on Weights and Measures (which Randall confused with the International Committee for Weights and Measures) voted to redefine the kilogram by fixing it via the value of Planck's Constant. This is measured using a Kibble balance, which involves passing a measured current through an electromagnet to exert a force to balance 1 kg. The change took effect on May 20, 2019, when the platinum cylinder International Prototype Kilogram that previously defined the unit was retired. This means that the mass of a kilogram is no longer tied to a physical object, but to the fundamental properties of the universe. By fixing the value of Planck constant to $6.62607015 \times 10^{-34} \text{ kg}\cdot\text{m}^2\cdot\text{s}^{-1}$, the kilogram is defined in terms of the second and the speed of light via the meter.

The previous method of confirming that a kilogram is accurate is to use physical metal weights measuring exactly one kilogram, periodically transporting them around the world to an official weight lab to confirm they still weigh the same. Over time these physical objects have changed very slightly in their mass making them unreliable in the long run -- thus running into the issue that a kilogram did not stay a constant measure of mass. Note that these weights and comparisons are so precise

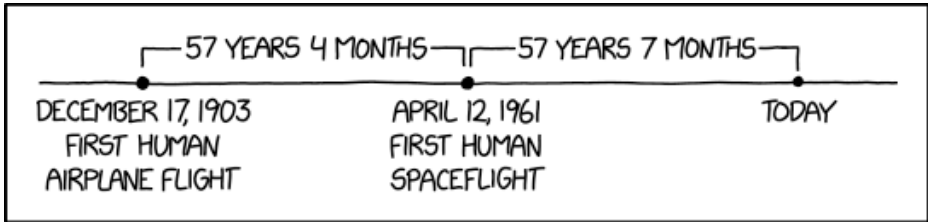
that a fingerprint on one of the weights could throw them off.

The new method of confirming that a kilogram is accurate relies upon an extremely precise knowledge of local gravitational effects and an absence (or counteraction) of electromagnetic interference. On a traditional scale, two units of equal weight will balance, regardless of local gravitational levels; whereas the new method requires that the gravitational force be determined precisely for every site, meaning an additional measurement has to take place. This involves a high-precision gravimeter such as the FG5 absolute gravimeter.

The title text continues the joke by saying that the meter has been defined as exactly three feet. The yard, the closest US measurement to the meter, is three feet. However, a meter is about 9 centimeters (~3.55 inches) longer than a yard. As with the pound, the metric system is used to define the yard as it is officially defined as 0.9144 meters. This joke recreates the comic in the real world, with Randall playing as Black Hat, and the reader responding. Those who fall for the claim will either be excited that things are simpler, or devastated at what the result will be.

#2074: Airplanes and Spaceships

November 19, 2018



SPACESHIPS ARE NOW OLDER THAN AIRPLANES
WERE WHEN WE FLEW OUR FIRST SPACESHIPS.

Despite having now taken three months longer than the airplane people, we're making disappointingly little progress toward the obvious next stage of vehicle: The Unobtanium-hulled tunneling ship from the 2003 film 'The Core.'

Explanation

This comic is pointing out that more time has elapsed since the first spaceship flight, than previously elapsed between the first airplane flight and the first spaceship flight. (This was at the time of release of this comic on November 19th of 2018, a month before the 115th anniversary for the first airplane flight).

Airplanes and spaceships are often considered to be related vehicles, under the term aerospace, with degrees in aerospace fields often having aeronautics (airplanes) or astronautics (spaceships) tracks. The jump in technology and performance between the first airplane and the first spaceship was enormous: the Wright Flyer had a max speed of 30 mph (48 km/h), and the first flights reached only about 30 feet (9 m) above ground, with distances of only 120 to 850 feet (260 m). In comparison the Vostok 1 mission of Yuri Gagarin reached orbital velocity of 17,500 mph (28,000 km/h), a minimum altitude of 91 miles (480,480 ft; 146 km), and traveled once around the earth (about 25,000 miles or 40,000 km). This represents an increase in performance of between about 600 and 150,000 times.

By contrast, an equal amount of time has passed between the first spaceflight and the publish date of this comic, but aeronautical performance has not improved much at all. Although the Apollo mission broke speed and altitude records, and later space missions extended the distance traveled in a single flight by sustaining Earth

orbit for longer, the overall technology and performance is not much different than that used during the first space mission.

It is one of the typical takes by Randall to try to make people feel old. Flight seemed old news when the Apollo mission started, so people who lived through the space race, will now feel very old since they were alive back when the space race is new, and that is now old news. This take is also used in the title text.

The title text refers to the 2003 film *The Core*. In this film, there is an instability in the Earth's magnetic field, so a team of scientists attempt to drill to the center of the Earth and set off nuclear explosions to restart the rotation of the Earth's core. To do this, they travel in a vehicle made of "Unobtainium" that can withstand the heat and pressure within the Earth's crust. Randall is sad to report that there is little progress being made on creating this vehicle. Incidentally, *The Core* is a film which represents science and engineering wrong in many, many aspects. There is a long list of flaws. For instance, if a material is resistant to the extreme heat and pressure of the Earth's core, then the significantly cooler and less forceful techniques of human metallurgy would certainly not be able to work that material at all, let alone craft it into a functional hull for a vehicle.

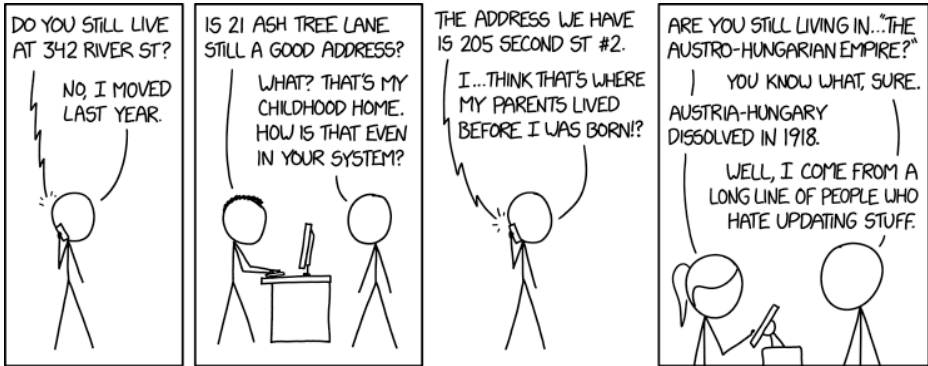
Randall makes sure to mention that the movie is from 2003, so 15 years old. Many people are surprised when realizing that a movie they saw "recently" is now so old that children born that year no longer need their parents'

guidance when watching it.

The Core was already used as the main plot starter in 673: The Sun back in 2009, and earlier in 2018 it was mentioned in the title text of 2011: Newton's Trajectories. That Randall has a great interest in the Earth's cores is shown in several comics, and may explain why he continues to return to the movie, even though he probably (taken from his comics mentioning it) thinks is a bad movie. See a recent comic here, 2058: Rock Wall and of course 913: Core.

#2075: Update Your Address

November 21, 2018



This is my four-digit PIN. It was passed down to me by my father, and someday I will pass it on to you. Unless we figure out how to update it, but that sounds complicated.

Explanation

In this comic, Cueball is facing several instances where entities asking or confirming his address find that the address they possess is incorrect - each address is progressively more outdated. In the final comic, Cueball gives up and confirms that yes, he is still living in a country that hasn't existed for over a century.

Inaccurate addresses may be a common problem for someone who has moved constantly in their lifetime. Alternatively, Cueball and his family do not find it important to update addresses for those particular businesses / entities.

Austria-Hungary was a European empire that existed between 1867 and 1918, dissolving during World War I. It is possible that Cueball's ancestors hail from the Austro-Hungarian Empire, though it would be even more absurd for that to be used as an address, given that the polity ended a century ago, whereas the earliest programmable computer was created 20 years after the country was dissolved and personal/small business computers approximately 40 years after that.

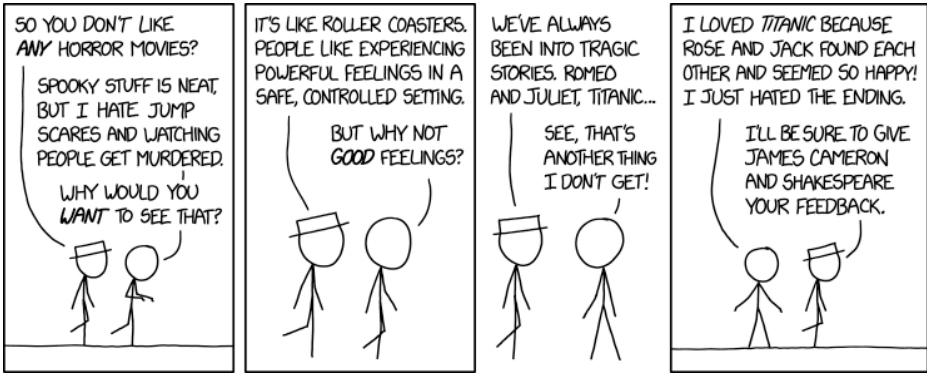
Ash Tree Lane refers to *House of Leaves*, a postmodern novel from 2000 in which one of many nested plots involves a house on Ash Tree Lane that is bigger on the inside than on the outside, and in fact contains a labyrinth with a minotaur. The book, and Ash Tree Lane specifically, have previously been referenced in 472:

House of Pancakes, 827: My Business Idea, and 886: Craigslist Apartments.

The title text treats bank accounts (and the PIN codes needed to access them) as though they were physical heirlooms passed down generation to generation. The patent for PIN codes was submitted in May 1966, and the first public use of a PIN code was in 1967, when Barclays used them to process cheques at automated teller machines. It would be unusual for Cueball to inherit both an active bank account and the PIN associated with it -- when a person with a bank account dies, the bank usually closes the account altogether and transfers the money to a separate account of whoever is named the beneficiary. Treating the account number and/or its PIN as though they were physical heirlooms plays into the joke of them not changing through the years (due to the perceived difficulty of updating them).

#2076: Horror Movies 2

November 23, 2018



When I was a kid, someone told me the end of *The Giver* was ambiguous, which surprised me. I had just assumed Jonah died—because the book had a medal on the cover, and I knew grown-ups liked stories where sad stuff happens at the end for no reason.

Explanation

This comic is the second in the Horror Movies series, and is the follow-up to 2056: Horror Movies released a month earlier.

While the first Horror Movies comic was about giving voice to Randall's inability to enjoy horror movies, this comic takes Randall's previous position and exaggerates it.

White Hat and Cueball (as Randall) discuss the appeal of horror movies and tragic plots. Cueball expresses his dissatisfaction with stories that focus on evoking negative feelings. As an example he mentions how he disliked the ending of Titanic where Jack sacrifices his life in order to save Rose. White Hat does not seem to share Cueball's point of view on successful storytelling and sarcastically promises to send feedback to the movie director James Cameron as well as the 16th century playwright and writer William Shakespeare, whose most famous works include tragedies like Romeo and Juliet.

In the title text Cueball (as Randall?) discusses the ending of the science fiction novel The Giver where the fate of the main character Jonas (misspelt here as "Jonah") had been left ambiguous. The joke is a stereotype that the Newbery Medal, a children's literature award, is only given to books with tragic endings. However, the protagonist lives, as there are three more titles in the series, two of which have the main

character as a side character. However, those three books are rather obscure.

This was the first of two comics in a row to reference a specific movie genre, this one horror movies, the next one, 2077: Heist, heist movies.

#2077: Heist

November 26, 2018



THANKS TO MOVIES, WHENEVER
ANYONE ASKS ME TO OPEN ANY
DOOR, I IMMEDIATELY ASSUME I'M
A MINOR CHARACTER IN A HEIST.

But he has a hat **AND** a toolbox! Where could someone planning a heist get **THOSE**?

Explanation

Heist films are a type of crime film, generally built around an elaborately planned and executed robbery. Because the drama of such films is based around defeating security measures, the thieves in such a film will often engage in a number of tricks, ploys, and strategies to get around those measures.

Once such measure involves one of the criminals posing as a repairman or something similar in order to gain access to a secure area. This is a form of social engineering which has been used by real life criminals, and is a very common trope in heist films. It takes advantage of the fact that lower-level workers frequently come and go in most facilities, and people tend to assume that someone who looks like such a worker and acts like they belong is exactly who they appear to be. In addition, most people aren't particularly vigilant about security, and demanding identification or verification before allowing access might seem inconvenient or impolite.

Due to the prevalence of this trope, Cueball is concerned whenever somebody asks him "to open any door", because that's exactly the kind of thing someone in a heist movie would do. In such movies, the person who opens the door is usually a "minor character", often having no purpose in the film other than opening the door. This causes concern, because in a heist film, that character will generally facilitate a robbery (or other attack), and possibly be disciplined for it. If the thieves

are more violent and remorseless, they might kill the character afterward to eliminate them as a witness.

In this case, he is asked to open the server room - ostensibly to allow the fire alarm to be checked. However, gaining physical access to the server allows the criminal to bypass most security features that should prevent unauthorized access to the data (a scenario known as an evil maid attack). If the hard disks are not encrypted it is trivial to copy all files or even remove and abscond with the disk drives - allowing the theft of sensitive information stored on the network. Even if the files are encrypted physical access to the server will allow the attacker to corrupt the system either by installing malware or adding malicious hardware components, which will then allow them to retrieve passwords and/or encryption keys.

Being aware of these dangers Cueball immediately assumes that he (or his employers) are the target of a heist.

The title text offers sarcastic reassurance, asking how a thief could have acquired a hat (possibly with a company logo) and a toolbox full of tools. This plays on the fact that, when people match our expectations of a particular role, such as having appropriate clothing and equipment, we tend to assume that's who they are, even when such clothing or equipment would be quite easy for an imposter to acquire.

This is the second comic in a row to reference a specific

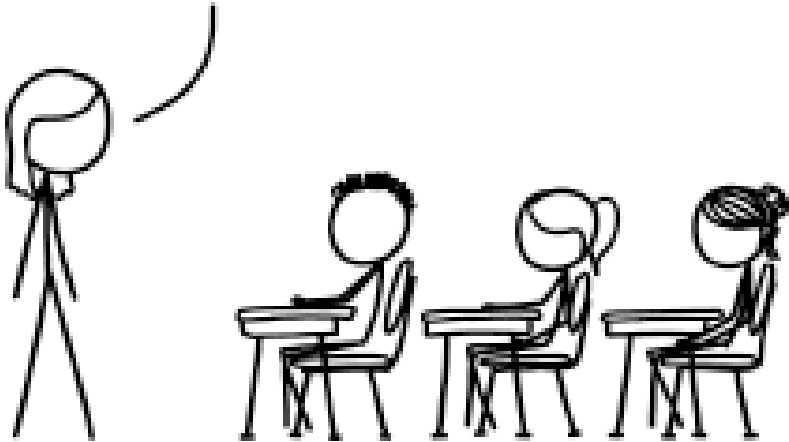
movie genre, this one heist movies. The previous comic, 2076: Horror Movies 2, referenced horror movies.

#2078: Popper

November 28, 2018

THERE'S NO EVIDENCE THAT
KARL POPPER WASN'T BORN
ON JULY 28TH 1902.

NO ONE HAS PROVEN THAT HE
DIDN'T GROW UP IN VIENNA...



At least, I don't think there's evidence. My claim that there's no evidence hasn't been falsified. At least, not that I know of.

Explanation

In this comic, Miss Lenhart teaches to a class consisting of Hairy, Ponytail, and Jill about Karl Popper. Karl Popper was a philosopher of science who endorsed the idea that science is distinguished from non-science by treating its theories as falsifiable. This means that science does not treat any theory as definitive, because future research could show that it is false.

A not uncommon reading of Popper assumes that instead of proving hypotheses, scientists are disproving hypotheses. This reading leads to technicalities like the ones stated in the comic: Instead of asserting that Popper was indeed born on July 28, 1902, and grew up in Vienna, a scientist can only assert that there is no evidence disproving these facts, which seems counter-intuitive because one cannot disprove the facts of Popper's birthdate and childhood residence.

Note however that falsifiability is often interpreted to mean that there has to be a way to disprove a given statement if it is wrong, or to distinguish between two mutually competing hypotheses – not that a statement is accepted solely due to the lack of evidence to the contrary. For example, a birth certificate is often used to establish a date of birth and falsifying that date of birth would then mean calling into question the birth certificate's authenticity or accuracy, but without any historical records of the date of birth one would normally not even speculate at all about the precise date of birth.

Such reasoning solely on the absence of proof to the contrary would be considered unusual in most contexts.

The humor comes when the comic applies this idea to the life and biographical information of Karl Popper himself. Note that, in real life, such a subject would be a matter for historical proof, not scientific, and would thus fall outside the realm of study Popper was thinking of.

The title text takes this reading a couple of steps further in a kind of meta-analysis. It points out that Miss Lenhart's claim of no evidence has not been proven false, and also that we're dealing with only the knowledge of a single individual who may not be aware of evidence that might exist.

Another reading of Popper points out that Popper's philosophy discarded proofs altogether as a defining feature of science. Thus, there is no such thing as definitive evidence in Popper's notion of science: even falsifying assertions themselves are seen as falsifiable.

#2079: Alpha Centauri

November 30, 2018



And let's be honest, it's more like two and a half stars. Proxima is barely a star and barely bound to the system.

Explanation

Alpha Centauri is the closest star system to our solar system, being about 4.37 light-years away. As such, there are numerous ongoing plans and projects to journey to, and explore the star system, especially since the exoplanet Proxima Centauri b was found in 2016 to possibly have liquid water oceans and a very thin atmosphere. Similar to this project, Ponytail announces such a project using a Voyager-like probe.

However, an offscreen person is against the idea of sending a probe to that particular part of the galaxy, as they think that "Alpha Centauri sucks". The person says that they looked "online" and that the system "only has three stars". This is a pun playing on the stars used in online reviews and stars as celestial objects.

Star Rating Systems[edit]

Online rating systems, such as Yelp, often use star rating systems, with more stars indicating higher quality, up to an arbitrary maximum, such as five stars to indicate the best rating. Due to the nature of 5 star rating systems, as shown in the comic 1098: Star Ratings, anything scoring less than 4 out of 5 in a 5 star rating system is crap; and in a 10-star rating system, scoring a mere 3 stars out of a possible 10 stars would be exceedingly low quality. The Alpha Centauri star system has 3 physical stars: Alpha Centauri A, Alpha Centauri B, and Proxima Centauri. The offscreen person has misconstrued this fact of the system as some kind of review.

The title text furthers the pun. Some online star rating systems also allow partial stars, such as a half-star, to allow more precision in rating (e.g. rating 2.5 stars instead of being forced to chose 3 stars or 2 stars), or display an average collective rating as partial stars (e.g. showing 2.5 stars when five people have rated 3 stars and five people have rated 2 stars). Alpha Centauri's "half star" refers to Proxima Centauri, a red dwarf, which is a type of low-mass star. According to the offscreen person, this barely qualifies it to be a star. Furthermore, Proxima Centauri is nearly 13,000 AU (0.21 light years) away from the other 2 stars in the system, so it was long unknown whether Proxima Centauri was gravitationally bound to the Alpha Centauri star system.

Calculations[edit]

All numbers are rounded after subsequent calculations.

According to space.com the fastest spacecraft ever will be the Parker Solar Probe which will reach 430,000 mph (692,000 km/h) as it reaches its closest point orbiting the sun. This is just over half of 1% of the needed speed of the Alpha Centauri vehicle proposed in the comic. The Voyager 1 spacecraft, launched in 1977, is currently traveling at about 38,000 mph (61,000 km/h).

Distance to Alpha Centauri system = 4.367ly

4.367 light years / 35 years = 0.12477ly per year

0.12477 light years/year * 5.879e+12 miles/light year =
733,484,000,000 miles/year

733,484,000,000 miles/year / 365 days/year / 24 hours/day =
83,000,000 Miles/hour / 1.60934 miles/kilometer = 134,000,000

Kilometers/hour

The above math assumes a constant speed, and requires a speed of ~0.124855c. Assuming a constant acceleration from rest (non-relativistic math follows):

$$35 * 365.25 * 24 * 60 * 60 = 1.10e+9 \text{ seconds in 35 years}$$

$$4.367 * 5.879e+12 = 2.57e+13 \text{ miles, } 4.13e+13 \text{ km, } 4.13e+16 \text{ m.}$$

$$x = 1/2 * a * t^2$$

$$a = 2 * x / t^2$$

Assuming constant acceleration to the halfway point and constant deceleration to the destination, (otherwise you streak through the system, barely observing anything):

$$t_{\text{trip}} = 2 * t_{\text{halfway}}$$

$$a = 2 * 2.06e+16 / (5.50e+8)^2 = 0.136 \text{ m/s}^2, \text{ roughly } 1/80 \text{ gravity.}$$

$$v_{\text{halfway}} = a * t_{\text{halfway}}.$$

$$\text{Top Speed: } 75,000,000 \text{ m/s} \sim 1/4 * c.$$

Assuming $E = F * d$, $0.136 * 1 * 4.13e+16 = 5.37e15$ Joules will be required for each kilogram carried to Alpha Centauri in 35 years.

This would require an unimaginable amount of mass for a conventional chemical rocket, and is a completely impractical power requirement for any sort of passive solar sail concept.

Further, the top speed is fast enough to require a recalculation using relativistic physics to model the problem. This means that

the energy budget will need to increase, as the relativistic mass of the probe will increase, requiring more force (and thus more energy) to accelerate and decelerate near its top speed than this calculation returns.

Active, laser based propulsion methods require currently non-existent and purely speculative laser and materials technologies, as well as a power plant equivalent to 12,500 of the World's Largest Nuclear Plant to transport sub-gram masses on this timescale. This also assumes that any probes can be steered accurately enough across interstellar distances to come close enough to image with any resolution the bodies they will be passing at a non-trivial fraction of c .

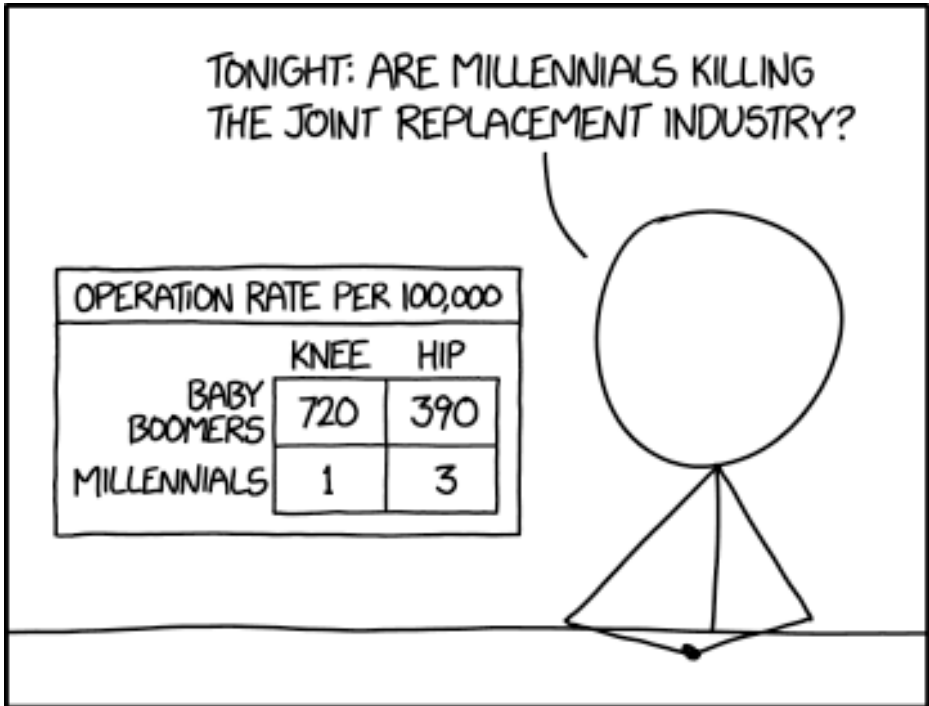
Short of FTL travel or near-perfect mass-energy conversion technology, transporting more than a fraction of a gram of material to Alpha Centauri in a human lifetime will be unachievable. Short of an enormous breakthrough in power generation, transporting even a fraction of a gram is impossible.

Nonetheless, Breakthrough Starshot is attempting to send many gram-sized probes to Alpha Centauri within the century. Following current technological trends, they expect the efficiency of laser-based propulsion to increase by launch time, allowing launches driven by an unreasonably-large-but-achievable amount of power. The top speed needed is halved by refraining from slowing at all at the destination: the probes will aim a distance away from the target, so that it traverses by slowly enough for a camera to rotate and track it, even at near-light speeds. To account for error and space dust, the plan is to launch many tiny probes simultaneously. They may only be able to accomplish their goal if they can get enough funding to actually affect the

global economy enough to make the technologies they require more efficient to produce. Launches would additionally burn incredible quantities of natural gas.

#2080: Cohort and Age Effects

December 03, 2018



STATS PET PEEVE: PEOPLE MIXING UP
COHORT EFFECTS AND AGE EFFECTS

Younger people get very few joint replacements, yet they're also getting more than older people did at the same age. This means you can choose between 'Why are millennials getting so (many/few) joint replacements?' depending on which trend fits your current argument better.

Explanation

Another of Randall's many Pet Peeves, this time it's statistics. It is the first in more than four years, since 1368: One Of The.

"Millennials" are the generation of Westerners who were born between the early 1980s and the late 1990s, whereas baby boomers are the generation born during the "baby boom", a period of high birth rates from the late 1940s to early 1960s. A common headline on news websites is "Millennials are killing the X industry" where X is a product whose sales have dropped in recent years, such as jungle gyms for kids. One of the most famous is the diamond industry, where a combination of the wage gap, stigma over conflict diamonds, increased knowledge of (in Randall's words) "The entire industry being built on a scam" "complicated gemstone market" and less desire to get married early has seen millennials buying less diamond jewelry than previous generations.

Randall spoofs this idea. In the comic, Cueball, as a news anchor, presents a heading which opens his story by asking if millennials are killing the industry of surgical joint replacements, illustrating it with numbers of joint replacement procedures among millennials compared to baby boomers. The joke is that millennials are simply too young for most of them to need joint replacements (which are usually used to treat senile osteoarthritis), so most people will see that so there really isn't a news story here. Randall is using this example to highlight that this

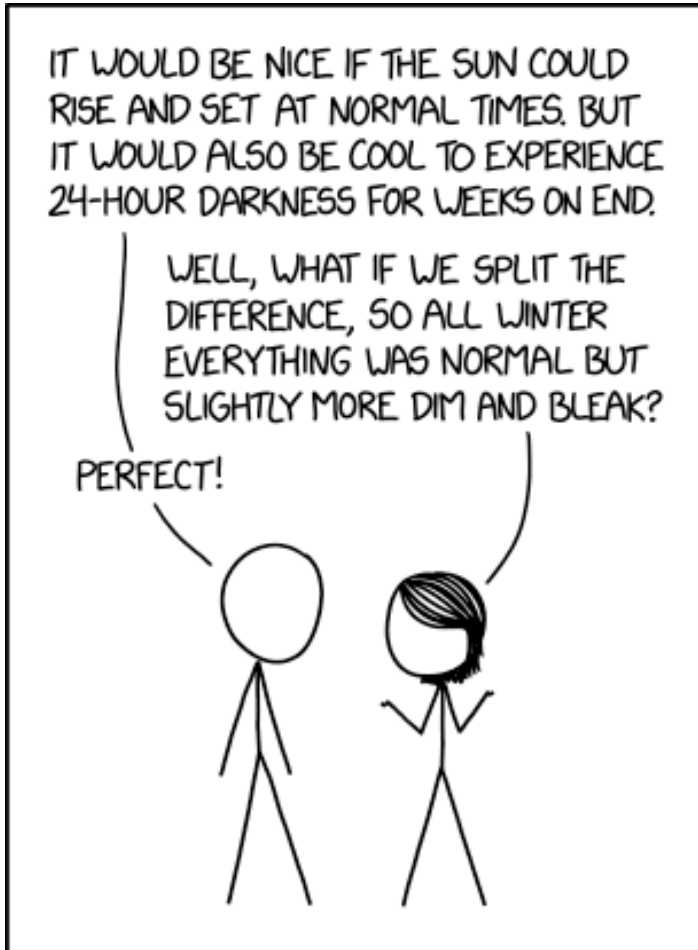
kind of story is ridiculous. Millennials will likely need joint replacements in the future as they get older, potentially keeping sales of joint replacements at close to their current rate.

A cohort effect is a cultural difference between generations (such as buying fewer diamonds), whereas an age effect is one that is simply related to getting older (such as getting arthritis). Joint replacement rates are an age effect, but the newscast is presenting them as if they were a cohort effect. (More correctly, the table rows would be labelled e.g. “people aged 53–72” and “people aged 17–36”.)

The title text points out that although numbers of millennials receiving joint replacements are low, they are higher than the numbers of baby boomers who received them at the same age—i.e. in their 20s—due to advances in medical diagnosis and technology in the last 50 years, as well as (in some countries at least) better access to healthcare. This statistic can be used to create a headline which is the reverse of the one in the comic, namely “millennials are getting more joint replacements than ever”. Randall notes that you could therefore use either headline to back up your argument, depending on the agenda you are trying to present.

#2081: Middle Latitudes

December 05, 2018



MIDDLE LATITUDES ARE THE WORST.

Snowy blizzards are fun, but so are warm sunny beaches,
so we split the difference by having lots of icy wet slush!

Explanation

Because of the Earth's axial tilt, the apparent daily path of the Sun through the sky - in particular, how long it takes and how high in the sky it gets - is different depending on how far North or South of the Equator you are (your latitude), and also changes throughout the year as the Earth revolves around the Sun. This fact yields two very important pairs of latitudes:

- Arctic Circle ($66^{\circ}33'$ North)
- Tropic of Cancer ($23^{\circ}26'$ North)

and

- Tropic of Capricorn ($23^{\circ}26'$ South)
- Antarctic Circle ($66^{\circ}33'$ South)

The latitudes that lie within these two bands are called the middle latitudes - also sometimes referred to as the North Temperate Zone and the South Temperate Zone respectively.

The Tropics of Cancer and Capricorn are the latitudes beyond which, if you go any further from the Equator, it is no longer possible for the Sun to be directly overhead at any time of the year. Similarly, the Arctic and Antarctic Circles represent the latitudes beyond which it is possible for the Sun not to rise or set at all at some times of the year.

In the middle latitudes - which occur between these

extremes - we instead get the rather less impressive phenomenon of daylight simply being a bit longer in summer and a bit shorter in winter.

In the comic, the middle latitudes are sarcastically proffered as a compromise between two extremes described by Cueball: day lengths that don't vary that much (as occurs in the torrid zone near the Equator), and no possibility of days with no daylight at all (as occurs in the Arctic/Antarctic zones). However, it is clear that Megan's compromise merely results in seasonal weather that has no interesting or useful features at any time of the year. In particular, winter is singled out as a season that is generally just dim and bleak in the middle latitudes, with days that don't last long and are cold and dull anyway.

The title text extends the idea with another spurious compromise, this time between snowy blizzards and warm sunny beaches - both of which are enjoyable in their own ways, but "splitting the difference" and combining the two would result in unpleasant icy slush.

There are other comics that refer to the length of the day, and how it is different each day, for example, 2050: 6/6 Time.

#2082: Mercator Projection

December 07, 2018



AT THIS POINT PEOPLE FEEL SO MISLED BY THE MERCATOR PROJECTION THAT YOU CAN USE IT TO CONVINCE THEM OF BASICALLY ANY MAP FACT.

The other great lakes are just water on the far side of Canada Island. If you drive north from the Pacific northwest you actually cross directly into Alaska, although a few officials--confused by the Mercator

distortion--have put up border signs.

Explanation

The Mercator projection is a map projection (a way to present the spherical Earth surface into a flat 2-D map) presented by Flemish cartographer Gerardus Mercator in 1569. It was the standard map projection for some time, because it does preserve all angles in their true shape (i.e. it is a conformal map projection). This means that if you measure an angle on the map you get the right direction in the real world - a very useful feature if you're using the map for navigating. However, preserving the angle leads to severe distortions of the surface area, especially in the higher latitudes where countries appear much larger than they actually are. For example on the Mercator Projection, Greenland (the largest non-continent island in the world) is shown to be much larger than Australia (the smallest continent), although the latter in reality is nearly 4 times as big. Other examples of regions having distorted sizes and shapes due to the Mercator Projection can be explored in this link.

Cueball uses White Hat's mistrust of the Mercator projection to convince him of ridiculous facts about Canada, namely that it is simply a small island in Lake Ontario. Map projections are generally continuous functions, meaning that they never map a disconnected space onto a connected one and therefore can never give the false impression that two areas that don't border each other do.

The title text continues on these falsehoods, claiming

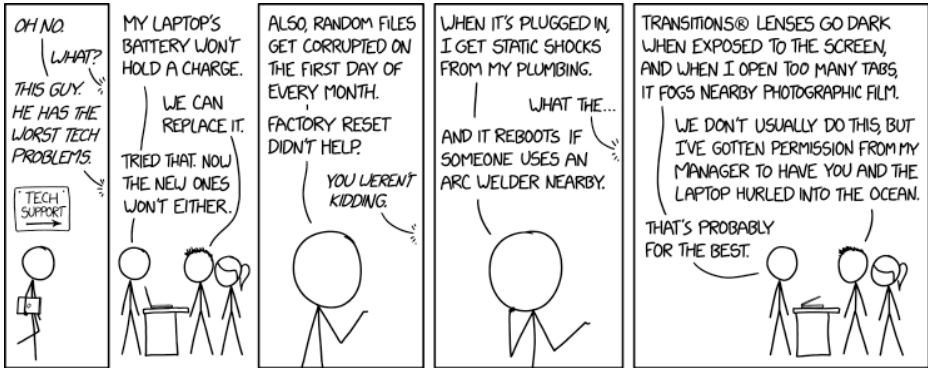
that the Great Lakes are simply "water on the far side of Canada Island", and that it is possible to drive directly into Alaska from the Pacific Northwest region of the US (in reality, Canada has a border with the contiguous states and Alaska). Cueball can possibly make these statements as Canada is a country in the northern regions, where the Mercator Projection would show it larger than it actually is. However, Canada is the second largest country in the world by total area (land and water), after Russia.

The Mercator Projection was previously mentioned in 977: Map Projections of "what your favorite map projection says about you". People who preferred the Mercator Projection was listed as "You're not really into maps." It is also the second comic in a row that relates somehow to latitudes. Bad Map Projections is a series in xkcd, showing that it is really something on Randall's mind.

It is not the first time Cueball (or Randall) tries to spread misinformation, for instance it also has White Hat as the target in 1677: Contrails, but it can also be other people that are fooled like in 1405: Meteor.

#2083: Laptop Issues

December 10, 2018



Hang on, we got a call from the feds. They say we can do whatever with him, but the EPA doesn't want that laptop in the ocean. They're sending a team.

Explanation

Cueball goes to tech support with his laptop. Hairy and Ponytail are waiting behind the counter; one has dealt with Cueball's bizarre tech issues before, and warns the other. Sure enough, Cueball sets the computer down and offers a detailed list of the arcane problems his computer is giving him.

The sheer incongruity of everything Cueball has reported, in combination with past issues, leads Hairy to report that his manager has authorized Cueball and his laptop be thrown into the ocean. Cueball accepts this without objection. This is a reference to 1912: Thermostat, where Cueball has an issue with his thermostat, and the Tech support employee asks him if he has tried walking into the sea. It seems this suggestion has evolved into forcefully throwing him into the sea, for lack of a better idea. It could also be that this is a reference back to the first of the series of comics on Cueball's many computer problems, 349: Success, where he ended up in the ocean. Alternatively, it seems very similar to the account of Jonah in the Bible, who was thrown overboard into the ocean during a violent storm after which the storm ceased.

The title text contains mention of the Environmental Protection Agency (EPA), a part of the United States government responsible for preventing pollution. In real life, most of a laptop computer's components are considered toxic waste, and the EPA, as part of their

mission, would not want it dumped in the ocean. More to the point, it's implied that whatever Cueball did to it renders it far more dangerous than an ordinary laptop, and the EPA really doesn't want his cursed possessions in the ocean; thus they are sending a hazmat team to collect the laptop and (attempt to) safely dispose of it. However, in the comic, the EPA do not seem to be bothered with Cueball himself being thrown into the ocean.

#2084: FDR

December 12, 2018

NAME	10/11/00
DATE	Dec 7/19 12, 2018
COUNTRY	United States

FDR WAS SO GOOD AT SPEECHES
THAT I SPEND A WHOLE MONTH EACH
YEAR WRITING THE DATE WRONG.

June 21st, 365, the date of the big Mediterranean earthquake and tsunami, lived in infamy for a few centuries before fading. Maybe the trick is a catchy rhyme; the '5th of November' thing is still going strong over 400 years later.

Explanation

The United States Naval base at Pearl Harbor, Hawaii was attacked in 1941, and is credited with starting the United States' involvement in World War II. The then US president, Franklin D. Roosevelt (FDR), issued a speech to the American people which begins with the line "Yesterday, December 7th, 1941, a date which will live in infamy...". Whenever Randall writes "December" he feels compelled to complete the line, a mistake which is visible in this comic.

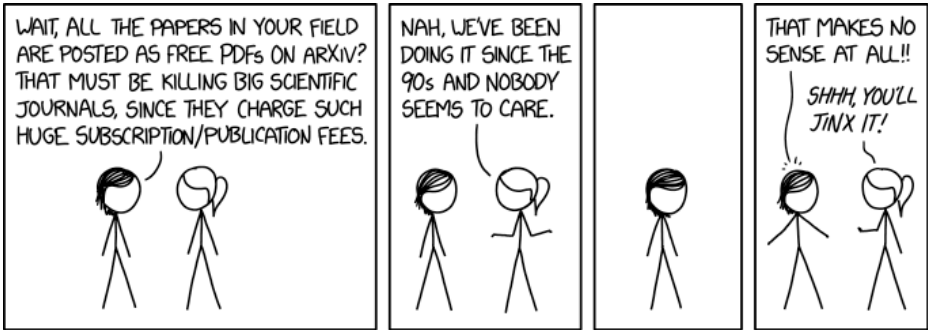
This may be a parody of a more common type of error in which people writing dates during January (particularly early in the month) accidentally write the previous year instead of the current one because the previous year number is an established pattern while the new one is a recent change.

The title text confuses the date of the northern hemisphere summer solstice (June 21st) with the date of the 365 Crete earthquake that happened on July 21st 365AD. The earthquake had a magnitude of at least 8.0 which caused widespread destruction across the Eastern Mediterranean. Then it mentions Guy Fawkes Night, the anniversary of the famous failed attempt to bomb Parliament on the night of November 5th, 1605. The latter event is immortalized in the rhyme "remember remember, the fifth of November, the gunpowder, treason, and plot", the former event less so.

Randall also may be suggesting that Roosevelt implied the degree of "infamy" of an event can be measured by how long its date is remembered. Pearl Harbor resulted in 2,458 deaths and obviously extensive damage to a military base and fleet. It had been remembered 77 years, as of the comic's publication. The earth quake of 365AD resulted in an estimated 230,000 killed and numerous cities severely damaged or destroyed. Randall states it was remembered for a few centuries. The Gunpowder Plot resulted in the death of a couple of conspirators and no notable damage. It has been remembered, at least in song, for "over 400 years".

#2085: arXiv

December 14, 2018



Both arXiv and archive.org are invaluable projects which, if they didn't exist, we would dismiss as obviously ridiculous and unworkable.

Explanation

arXiv is a free online repository of electronic preprints of scientific papers in various fields, particularly in physics, math, and computer science. Scientists typically publish "preprint" versions of journal articles to arXiv, which are free to publish to and read. In this comic Megan remarks that academic journals must have a hard time getting by since their primary revenue is from researchers who pay to publish articles and readers who pay for subscriptions. Her remark seems to assume that arXiv must be a recent development, perhaps similar to the Sci-Hub project which began in 2011. However, Ponytail informs her that the arXiv project has been around since the 1990s (1991 to be exact).

After a panel of Megan looking contemplative, she remarks that that does not make sense at all. After all, why would publishing companies be able to make money from something that is free online? Ponytail tries to stop her from freaking out, so that her outrage does not inform others about the current arrangement and thus ruin the system. She uses the term "jinx", which in common usage means to affect negatively by speaking about, to imply that this system is one that could break down if discussed.

Ponytail expressing confusion about the continued existence of scientific journals previously happened in 2025: Peer Review.

The title text refers to another project that is invaluable for internet research, the Internet Archive ([link to it here](#)). Internet Archive is a public archive of information, including public domain books and music. Internet Archive runs the Wayback Machine, an archive of backups of web pages all over the Web at various times that can be used to see past versions of a page, even if that site has since shut down. Internet Archive accepts submissions of any type of information, including new backups of web pages and newly-made public domain content. The title text argues that these two projects are so useful, yet make so little economic sense, that, if they did not exist, we would dismiss them as ideas that would never be viable. In addition, as "arXiv" is intended to be pronounced the same as "archive" (the English letter X is derived from the Greek letter χ , pronounced "Kai"), both sites have URLs with a common pronunciation.

#2086: History Department

December 17, 2018



When we take into account the recent discovery of previously-unstudied history in the 1750s, this year may have been an outright loss.

Explanation

In this comic Ponytail is a representative of the history department, which might be a department of a university or other organisation. She presents the year report of 2018. In this, she explains, the department has fully analyzed over four months of history. In the meantime, due to the passage of time, another year of history has been added to their workload (implied to be the year spanning between the current meeting and the previous one).[citation needed] This presents a cycle in which the department would only be able to keep up if they could analyze, within a one year period, more than or exactly one year of history.

A department in a business, such as the finance department, is typically required to keep up with their own workload and complete an entire year's worth of workload every year. A business that fails to manage this minimum would almost certainly fail: bills would not get collected, invoices would not get paid, employees would not get paid, etc. A history department fails to follow this model in two very important ways. First, the subject of history cannot be fully processed. New discoveries change what we know about certain time periods. Even current events cannot be fully processed, as future events will cause historians to see connections in things not previously thought to be connected. Second, the standard model for history departments focuses on specific eras or specific subjects for the purpose of explaining the events to students. History departments

do not process years, but instead process the subject so that it stays relevant to the understanding of the current student body.

There are, however, long running historical projects that have suffered this very problem. An example is the *Histoire littéraire de la France* which began publication in 1733 with a volume covering up to the year 300. By 1995 over 40 volumes had been published, but the historical account had only reached the 14th century. The volumes for the 14th century had taken 130 years to produce. Although over the 250 years of the project publication had been proceeding faster than time elapsed, the proliferation of literary content following the dawn of printing in the 15th century is likely to cause the project to slip further into reverse.

The title text further expands this problem by indicating the discovery of a new era of history that had previously gone un-analyzed, which would have added more undiscovered history than it removed. The 1750s decade is possibly a reference to the adoption of the Gregorian Calendar by the British Empire.

Randall previously mentioned that history is huge in 1979: History.

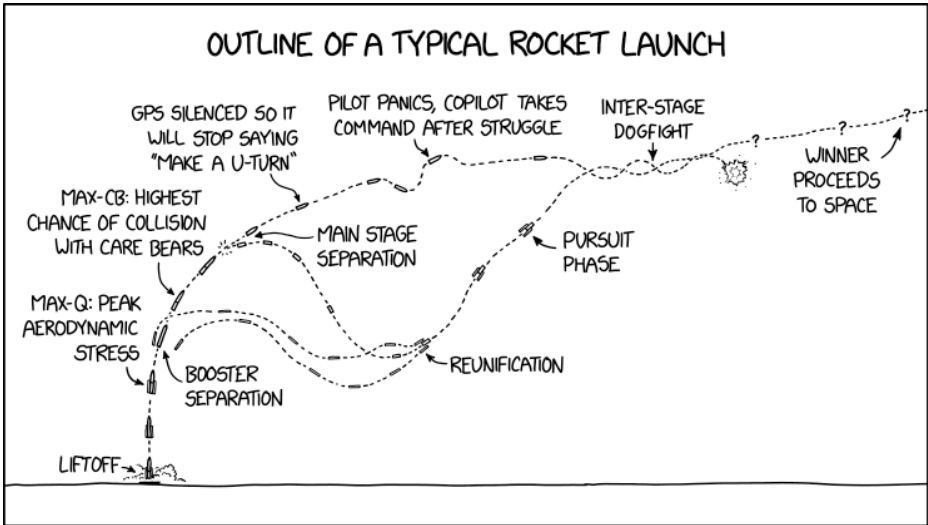
Events in the dates listed:

- November 1833: A Leonid meteor shower occurred in North America (Leonids#1800s); an 8.7 earthquake struck Sumatra.

- April 19-22, 1979: April 20: President Jimmy Carter was attacked by a swamp rabbit. This was referenced directly in 204: America, so is most likely the reason this period has been included; April 22: the Albert Einstein Memorial was unveiled at The National Academy of Sciences in Washington, DC.
- May 21-25, 585 BCE: Possibly a reference to the solar eclipse that actually happened May 28, 585 BCE, or to the war between King Alyattes of Lydia and King Cyaxares of Media that ended after said solar eclipse.
- June-August 1848:
- May 16, 2001: The neo-noir mystery film Mulholland Drive premiered at the 2001 Cannes Film Festival. In addition, the Timothy McVeigh execution was originally scheduled for this date.

#2087: Rocket Launch

December 19, 2018



NASA tries to coordinate launch timing with the Care Bears' cloud castle, but unfortunately sometimes collisions with stray Care Bears are unavoidable, so they just try to make the fairings sturdy and hope for a glancing impact.

Explanation

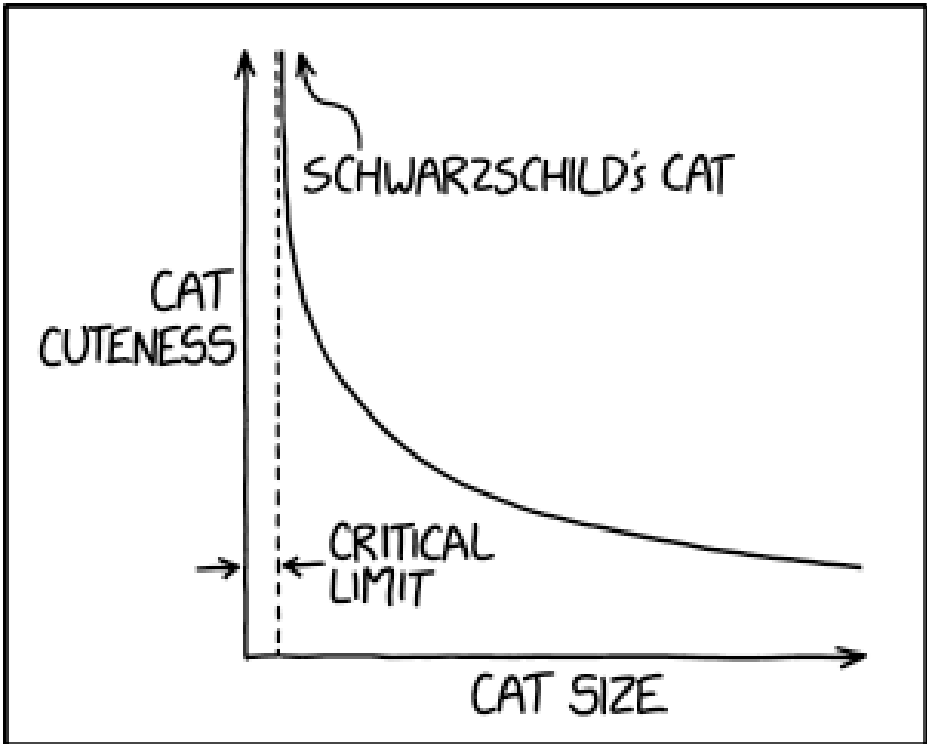
This comic was posted on a week with a notably high number of rocket launches. Originally, there were to be four orbital rocket launches from the United States on December 19, 2018 (the publish date for the comic), which would have tied with the prior record for number of orbital rocket launches in one day. While these launches were ultimately delayed, breaking the event, the comic was doubtless under production by then.

Only some of the steps listed are actually typical.

The title text refers once again to the Care Bears franchise. The Care Bears live in a castle made of clouds, called Care-a-Lot Castle, so the comic claims that NASA aims to avoid launching into their castle, but sometimes cannot avoid hitting "stray" Care Bears. That being said, the point about the strike has a basis in truth; at the speeds a rocket moves, impact with something roughly the size and weight of a human (or a Care Bear) has the potential to be catastrophic. If something should threaten to connect with the rocket, the best that the humans involved can do is hope for a glancing blow with a part of the rocket sturdy enough to endure the impact.

#2088: Schwarzschild's Cat

December 21, 2018



Cats can be smaller than the critical limit, but they're unobservable. If one shrinks enough that it crosses the limit, it just appears to get cuter and cuter as it slowly fades from view.

Explanation

This comic is primarily a wordplay joke about the Schwarzschild radius, or the distance from a black hole corresponding to the event horizon. The Schwarzschild radius for a given body is the limit to which a given mass can be shrunk down before it becomes a black hole - the Schwarzschild radius also represents the event horizon of this newly-created black hole. The event horizon, in turn, is the limit from which nothing can leave a black hole; not even light. The joke is that, apparently, smaller cats are cuter, and there is a limit below which a sufficiently small cat (but larger than zero) will approach infinite cuteness, in a similar pattern to the way time's rate for an observer will approach infinity, the closer they get to the event horizon of a black hole.

It's also an oblique reference to the Schrödinger's cat thought-experiment, since the names (Erwin) "Schrödinger" and (Karl) "Schwarzschild" are somewhat similar and both men were early 20th-century physicists who exchanged ideas with Albert Einstein. However, the actual comic doesn't bring up quantum superposition.

The title text makes two allusions. First, it alludes to what happens when an object falls into a black hole. From an outside observer's point of view, such objects appear to slow down and take an infinite amount of time to cross the event horizon due to the time dilation of General relativity. The object's photons become increasingly red-shifted, fading as they lose energy to the black hole's

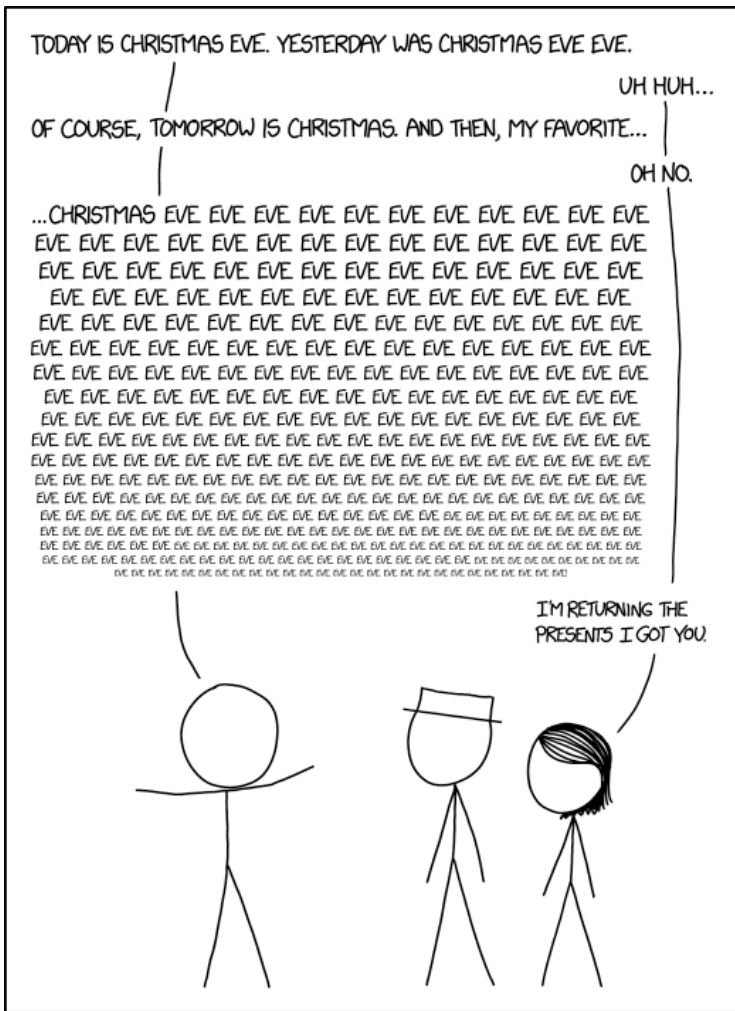
gravity well. The scientific consensus suggests that from the falling object's point of view, it should continue to experience time and cross the Schwarzschild radius, but that event is unobservable from the outside (hence the term "event horizon").

Second, the title text is a play on the Cheshire Cat from *Alice in Wonderland*, which slowly fades from view until only its grin remains.

Randall previously discussed the superiority of tiny mammals in 1682: Bun, and drew graphs relating to the perceived cuteness of cats in 231: Cat Proximity.

#2089: Christmas Eve Eve

December 24, 2018



It turns out that saying "Oh, so **THAT'S** why they call it **Boxing Day**" is a good way to get punched a second time.

Explanation

This year's Christmas comic was posted on December 24, 2018, the Christmas Eve of 2018.

The evening or day preceding a special day such as a holiday is often referred to as the eve of that day (derived from the same word from which we get evening). Thus December 24 is Christmas Eve. Some people extend this and call December 23 "Christmas Eve Eve," as Christmas Eve is itself a noted holiday. The day before that would be "Christmas Eve Eve Eve," adding one "Eve" for each night before Christmas morning, although the increasing extension leads to each additional "Eve" being continuously less common.

Cueball notes the general idea, and Megan acknowledges it. Cueball follows by naming December 24 as Christmas Eve, December 25 as Christmas, and then mentions that the following day is his favorite. Megan's "Oh no" implies that she knows what Cueball will say next.

Since December 26 is the 364th day before Christmas (when the following year is not a leap year, which was correct in 2018 when the comic was released), it follows that it is "Christmas" followed by "Eve" 364 times.

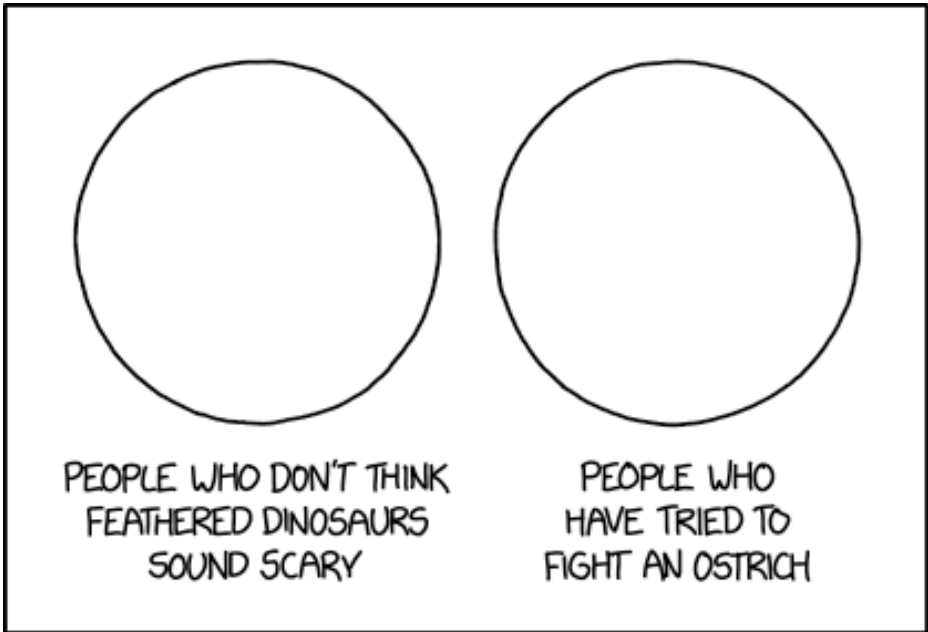
Megan finds listening to Cueball recite this unacceptable. As such, she announces that she will not give him gifts, taking the extra step of returning the gifts she'd already bought. As Christmas presents in America are first

handed out on Christmas Day's morning (unless the giver and recipient are aware in advance they will be unable to meet in person on that day; Megan's presence on Christmas Eve indicates this is not a threat), she has not given it to him yet.

The title text refers to the Boxing Day holiday celebrated the day after Christmas in the UK and many parts of the former British Empire. Although the exact origin of the name is unknown, it is believed to be in reference to the Alms Box placed in areas of worship to collect donations to the poor, which was then opened right after Christmas. Most Americans don't know this and make jokes about how it refers to the sport of boxing. In this title text we can presume Cueball was punched (or boxed) after his litany of 364 Eves, to which he replies, "Oh, so that's why they call it Boxing Day." As this is a pun of groan-inducing triviality, he receives another punch.

#2090: Feathered Dinosaur Venn Diagram

December 26, 2018



My pet theory is that in real life, the kid at the beginning of Jurassic Park who made fun of the 'six-foot turkey' never got a talking-to from Dr. Grant, and grew up to produce several of the movie's sequels.

Explanation

Translated plainly, this comic reads "People who don't think feathered dinosaurs sound scary have never tried to fight an ostrich."

This comic is a jab at people who dismiss the idea feathered dinosaurs sound scary. Adding feathers to a reptile can trigger a cognitive dissonance; people today see feathers and think of harmless birds. However, the ostrich and a few other avian species, which are feathered dinosaurs (1211: Birds and Dinosaurs) are in fact deadly. The diagram points out that anyone who has tried to fight an ostrich would be scared of a dinosaur with feathers, and anyone who thinks a feathered dinosaur doesn't sound scary has never tried to fight one. The two groups of people are exclusive because the two circles do not overlap.

Ostriches are not typically considered scary or dangerous because its appearance is comical or awkward to most people; they are also herbivorous and not typically aggressive, choosing to use its great speed to outrun predators rather than fight them. In reality, however, ostriches are much larger than a human and will attack when cornered or when their family is threatened; their powerful legs can kick hard enough to kill lions and other predators, and their feet are equipped with large claws which can disembowel a human. Thus, the actual experience of fighting an ostrich would quickly convince any human that survives the experience that ostriches

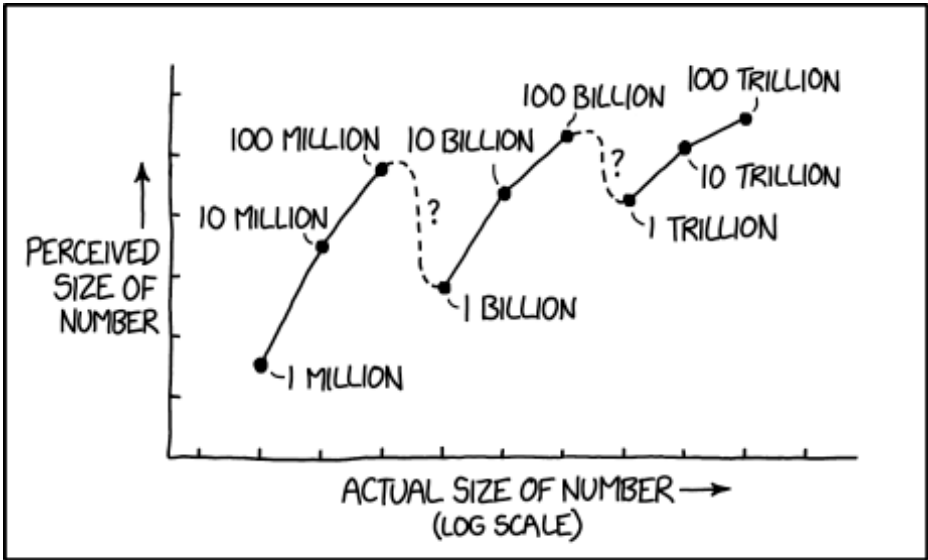
(and by extension other feathered dinosaurs) are, in fact, scary.

The title text refers to "Volunteer Boy", a kid in the beginning of Jurassic Park who dismisses a raptor fossil as a "six-foot turkey". Dr. Grant uses a fossil of a raptor talon to imply that a raptor would slice open his belly and eat him while he's still alive. This scares the kid into respecting the raptor. The title text theorizes that if he didn't get that pep talk, and continued to think of dinosaurs as "six-foot turkeys", then he would grow up to make some of the contested sequels in the franchise. Raptors play a central role throughout the series of movies, with some even being trained by a raptor handler like dogs.

Technically, the diagram is an Euler diagram, rather than a Venn diagram. A Venn diagram shows all possible combinations of two or more sets, including those with no elements, and so all of the regions must intersect in all possible combinations. An Euler diagram only depicts the non-empty combinations, and therefore does not have this constraint. However, this is a technicality, and many people use the words interchangeably.

#2091: Million, Billion, Trillion

December 28, 2018



TALKING ABOUT LARGE NUMBERS IS HARD

You can tell most people don't really assign an absolute meaning to these numbers because in some places and time periods, billion has meant 1,000x what it's meant in others, and a lot of us never even noticed.

Explanation

Much like comic 558, this comic addresses the difficulty ordinary people have with large numbers. Though most if not all people intuitively understand the difference between one object and two objects, or one object and ten objects, or even one object and a hundred objects, as numbers increase most people's ability to innately conceive of the numbers being discussed decreases remarkably quickly. When numbers reach the millions and the billions, and especially the trillions, most people don't truly process the numbers at all, and instead conceive of them as some version of a drastically-oversimplified concept such as "very big." Where comparing one to ten is simple, comparing "very big" to a different "very big" can prove extremely challenging, and will certainly require non-intuitive, conscious thinking.

The comic represents this challenge by providing a graph which represents Randall's intuitive conception of the values of various very large numbers, and said conception's misalignment with reality. Though some trends reflect the real value of the numbers on the graph, i.e. 100 million larger than 10 million larger than 1 million and 1 billion larger than 1 million, the curve is far from the linear (exponential on the log-scaled axes) path it should take, with 1 billion being intuitively understood as less than 100 million, based, presumably, on the fact, easily comprehended on an intuitive level, that 100 is larger than 1, and therefore the presence of 100 in 100

million places it at a higher value than the 1 in 1 billion would place the latter. In reality, of course, 1 billion is ten times larger than 100 million, but the comic deals not with actual reality, but with the perception of reality of these numbers before conscious thought is applied.

The most interesting parts of the graph, and the parts where the disconnect between intuition and reality becomes clearest, are the dashed sections labeled with question marks, the one between 100 million and 1 billion, the other between 100 billion and 1 trillion. Here two competing intuitive understandings compete for dominance. On the one hand, the intuitive understanding described above, with 100 trumping 1, would see the curve taking a sharp downturn. On the other hand, the path from 100 million to 1 billion is paved with such numbers as 500 million, 700 million, and 900 million, all of which would theoretically be seen intuitively as larger than 100 million, thanks to the fact that 9 is greater than 7, and 7 greater than 5, and so on, bending the curve up rather than down. These two conflicting intuitions leave Randall with no single intuitive path for the two dashed sections, leading to their dashed and questioned state.

The comic's caption and title highlight another problem surrounding the intuitive grasping of large numbers: the flaws in the English words used for them. For instance, nothing about the word "million" suggests smallness relative to the word "billion" on an intuitive scale. This unintuitive language contributes greatly to the "100 trumps 1" intuitive fallacy described above.

Long scale and short scale[edit]

The title text references a highly relevant disconnect between the long and short scales of large numbers.

For all English speakers, and for most languages, 1 million constitutes 1,000 thousands, or, less ambiguously, 10^6 . However, this is the last of the consensus numbers, and the definition of what should be the "next step" varies depending on how each country's language evolved.

- In many English-speaking countries, 1,000 millions equals 1 billion, or $1000 \cdot 10^6 = 10^9$; this convention is known as the short-scale.
- In historical Britain and many other countries with a language derived from French, German or Spanish, the "next step" may be named a thousand million, and 1 billion equals 1 million millions, or $10^6 \cdot 10^6 = 10^{12}$, with the base unit changing when you have a unit's worth multiple of the unit; this convention is known as the long-scale (note that this is no longer used in the United Kingdom and Ireland since 1974).
- In European languages where the long-scale system is used, 10^9 may be named a thousand million, or receive a name with a special suffix: the word milliard (meaning 1,000 million) is used in some form (e.g. milliard in French, Milliarde in German, milliard in Danish, milliárd in Hungarian, etc.), with the word billion defined as 1,000 milliard (or 1,000,000 million). In these languages, a billion never meant 1,000 million as it does in the short-scale system.
- Successive units, such as trillion, increase by the same multiple as one billion divided by one million - by 1,000 in the short-scale

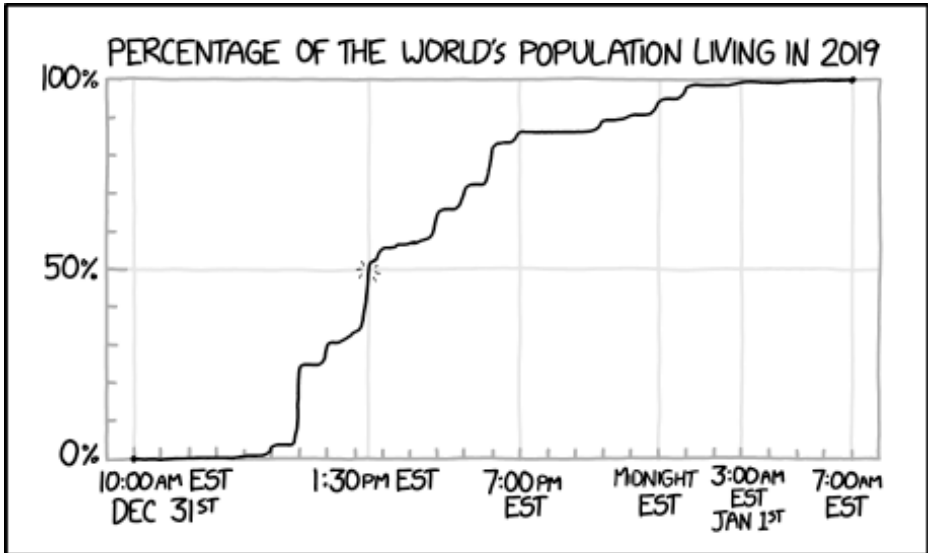
system and 1,000,000 in the long-scale system.

In other words, 1 billion objects in a country using the short-scale would be 1,000 million objects in a country using the long-scale; at the "next step", 1 trillion in the short-scale would be named 1 billion in the long-scale, despite the fact that the number of objects has remained the same. This difference between languages using the short-scale and the long-scale often causes confusion when translating articles with large numbers in them, as translators sometimes fail to change between short-scale and long-scale schemes, wrongly translating large numbers to incorrect values.

The fact that such a staggering difference of terminology was able to exist and be almost completely unknown to many supports Randall's point about the failure of human intuition in the discussion of extremely large numbers.

#2092: Consensus New Year

December 31, 2018



CONSENSUS NEW YEAR: AS OF 1:30PM EASTERN TIME (6:30PM UTC) A MAJORITY OF THE WORLD'S POPULATION WILL BE LIVING IN 2019.

The biggest jump is at 11:00am EST (4:00pm UTC) when midnight reaches the UTC+8 time zone. That time zone, which includes China, is home to a quarter of the world's population. India and Sri Lanka (UTC+5:30) put us over the 50% mark soon after.

Explanation

In this New Year comic, Randall is proposing a compromise for when to celebrate, or recognize, New Year's Day. These celebrations traditionally take place at the stroke of midnight between Dec. 31st and Jan. 1st, at the local time of the event's location. With "Consensus New Year", these celebrations would happen at the same time, world over, and would be at exactly 1:30 pm EST (6:30 pm UTC). At this time, about half the world's population would be in 2018 local time and the other half would be in 2019. This is due to the various time zones throughout the world, and the graph is based on the proportion of the population in these zones.

This is based on the assumption that the entire world uses the same calendar system. Randall's graph shows the year starting on the same day for the entire world. While the Gregorian calendar is used as the civil calendar in most countries of the world, the Eastern Orthodox churches uses the Julian calendar, on which the year will begin 13 days later, and the year (as of December 2018-January 2019) is 1440 on the Muslim calendar and 5779 on the Hebrew calendar. Other countries have the same New Year as the Gregorian calendar but count years differently; for example, 2019 is the year 108 in Taiwan and 2562 in Thailand.

The Wiktionary entry for "consensus" includes multiple definitions, including these two meanings:

- (attributive) Average projected value
- General agreement among the members of a given group or community

In an attributive grammar structure, a noun is placed before another noun to assign an attribute to it. When "consensus" is used this way, it's a statistical term which means the average projected value of the modified noun.

Randall properly uses this first definition for both the title of the comic and the graph itself, where the graph represents the average projected value of the percentage of the world population reaching the new year at any given time.

Randall may be purposefully misusing the second definition of the word "consensus" to reflect the common misuse of the term consensus for the practice of majority vote.

In scenarios involving group decision-making, consensus means that all or almost all members of the group will accept the decision. Depending on how it is done, this generally results in a slower decision-making process due to discussion, but decisions that many more people are happy with. Consensus can scale to large groups of people using approaches such as the spokescouncil model to speed dialogue. By this definition, Consensus New Year happens at one of the last four time zones as the last to "agree" enter 2019, so (nearly full consensus definition) 4:00 am, 5:00 am, 6:00 am, or (full consensus definition) 7:00 am EST on January 1, 2019.

Consensus lies in contrast to majority vote, where a decision passes when over 50% of the people desire it. Majority vote is used in most current large democracies and is what most people are familiar with. It is quick to describe and implement, but can result in polarized political parties and a stark lack of minority rights, unless enough people develop concern for the issues that they are tempered with constitutions and logrolling.

The leftmost horizontal axis label (10am EST Dec 31st) was an error. The point marked as 0% should be 5am EST (see table below).

Additionally, some of the lines are shown with a slope, which is inaccurate. Since sun time is not used anywhere, a correct graph line would only consist of horizontal and vertical lines.

Time zones[\[edit\]](#)

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